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Influence of compost application on soil surface without incorporation on selected physical properties of soil

Master´s thesis

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Declaration

I hereby declare that I have authored this master's thesis carrying the name **Influence of compost application on soil surface without incorporation on selected physical properties of soil** independently under the guidance of my supervisor. Furthermore, I confirm that I have used only professional literature and other information sources that have been indicated in the thesis and listed in the bibliography at the end of the thesis. As the author of the master's thesis, I further state that I have not infringed the copyrights of third parties in connection with its creation.

In Prague on the April 14th, 2023 ______________________________

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Influence of compost application on soil surface without incorporation on selected physical properties of soil

Summary

Soil is a vital natural resource that supports diverse ecosystems and is crucial for agriculture and the environment, however, soil degradation is a major concern around the world. The concern increased, too, in the Czech Republic due to intensive land use and management practices, which have led to soil erosion, nutrient depletion, and compaction. There are many practices that can be implemented to improve soil quality, ranging from natural methods to modern technologies, one of them is the use of compost as a natural amendment.

Compost application and specifically, compost without incorporation is a method of applying the amendment over the surface without physically mixing it with the soil. Instead, the compost is applied as a mulch on the soil surface, where it slowly decomposes and releases nutrients into the soil. This thesis project aims to investigate the impact of compost application without incorporation on selected physical properties of soil, including soil organic matter content, saturated hydraulic conductivity, aggregate stability, and soil water content.

This study was conducted in three localities Jevíčko, Velké Hostěrádky, and Praha-Uhříněves, which are presented as semi-operational experimental fields where maize and grain are the crops. In total 77 undisturbed representative soil samples were collected from control plots and plots treated with surface-applied compost as mulch into Kopecky rings, and corresponding amount of disturbed soil samples.

Upon conducting statistical data analysis, it was determined that the application of compost without incorporation to the soil in treated parcels had a positive impact on soil physical properties. This was evident in the increase observed in all analyzed parameters, including saturated hydraulic conductivity, water content, aggregate stability, and soil organic matter content, across all three localities. These findings have important implications for the development of sustainable soil management strategies that can effectively address issues related to soil degradation and support agricultural production.

Keywords: Compost, mulch, soil organic matter, saturated hydraulic conductivity, soil water content, aggregate stability.

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1 Introduction

Soil is a crucial natural resource that supports diverse ecosystems, including forests, grasslands, wetlands, and farmland. It is essential for promoting crop growth and yields in agriculture, supplying plants with vital nutrients, water, and oxygen. Soil quality significantly influences agricultural production and sustainability, and measures must be taken to protect and enhance its health. Beyond agriculture, healthy soil also plays a critical role in carbon sequestration, biodiversity, and water quality (FAO & ITPS 2015). It provides a habitat for a wide range of plants and animals while filtering and controlling water flows, reducing erosion, and mitigating the risk of floods and droughts. As a significant carbon sink, soil traps a considerable amount of carbon that would otherwise contribute to climate change (Doran & Zeiss 2000). Moreover, it plays a crucial role in sustaining life by providing the basis for plant development and support for food systems.

Specifically in the Czech Republic, the unique geology and climatic conditions of the country are reflected in the complex and varied soils, that sustain a variety of ecosystems and offers vital natural resources for the populace and economy, such as food production. However, soil degradation caused by intensive land use and management practices is a growing concern worldwide.

The application of organic amendments, such as compost, is one of the methods enhancing soil quality and restoring deteriorated soils. Composting is a process with significant environmental and agricultural benefits, one of the most significant benefits is that compost can improve the physical, chemical, and biological qualities of soil and increase its fertility and production potential. The practice of composting can help to minimize the amount of organic waste sent to landfills, which in turn mitigates the emission of methane.

Traditionally, compost has been incorporated into the soil to improve soil fertility, structure, and water-holding capacity. Incorporation involves tilling or plowing compost into the soil, allowing it to mix with the soil, and providing the plant roots with access to the nutrients and beneficial microbes in the compost. This practice has been shown to increase soil organic matter content, improve soil structure, and reduce soil erosion.

However, in recent years, the use of compost as mulch, where it is applied to the soil surface rather than being incorporated, has gained attention. The use of compost as mulch offers several benefits, such as reducing soil evaporation, controlling soil temperature, suppressing weed growth, and increasing soil organic content. Additionally, applying compost as mulch reduces the amount of labor required for soil incorporation, which can be time-consuming and expensive. Some research has shown that the use of compost as mulch can be an effective alternative to soil incorporation for some crops and soils, and it may also reduce the loss of nutrients and greenhouse gas emissions associated with traditional tillage practices. While traditional soil incorporation of compost remains a valuable practice, the use of compost as mulch offers an alternative technique that can provide several benefits in terms of soil health, crop productivity, and sustainability.

Therefore, this thesis project aims to investigate the influence of stable compost application on soil surface without incorporation on selected physical properties of soil, including soil organic matter content, saturated hydraulic conductivity, and soil water content. The results of this thesis project will offer new information about the potential advantages of using stable compost applied without incorporation for selected agricultural fields in the Czech Republic to enhance soil physical qualities and promote sustainable soil management practices.

2 Scientific hypothesis and aims of the thesis

Scientific hypothesis

Application of stable compost onto the soil surface without incorporation will lead to positive changes in the observed soil physical properties.

Aim

To observe the soil behavior at several localities after surface application of compost in terms of soil properties such as organic matter content, saturated hydraulic conductivity, soil water content and aggregate stability.

3 Literature review

According to the European Environmental Agency (2023), compost is a material made from various organic wastes that can be decompose by the action of different aerobic microorganism, this material is applied to the soil as a natural fertilizer to aerate it and to increase organic matter and nutrients necessary for plant growth. A procedure called composting is used to produce compost, therefore, composting is an aerobic biological process that converts degradable organic waste into a stable and sterilized product that can be used as fertilizer.

In contrast, Britannica (2023) defines the process of composting as "the biological decomposition of organic material into a dark, humus-rich, soil-like material." This definition emphasizes that composting is a biological process driven by microorganisms that break down organic material. The product of composting is a dark, humus-rich material that can be used as a soil amendment to improve soil fertility, structure, and overall health. This nutrient-rich material is similar to the soil and can provide essential nutrients for plant growth while enhancing the physical properties of the soil.

In addition, composting is defined by National Geographic Education Blog (2023) as the natural process of recycling organic materials, such as food scraps and yard waste, into a nutrient-rich soil amendment. This nutrient-rich compost can be used to improve soil fertility and support plant growth, making it a sustainable and environmentally friendly practice.

3.1 Compost

The finished compost is a stable and matured product that has undergone the decomposition of organic materials and has reached a stage where it can be used as a soil amendment. Compost quality can be assessed through various indicators (Amery et al. 2020), including:

Nutrient content (N, P, K): Compost typically contains essential nutrients like nitrogen (N), phosphorus (P), and potassium (K), which are important for plant growth. The nutrient content of compost can vary depending on the feedstock and composting process, but in general, well-made compost should have a balanced nutrient profile suitable for supporting plant growth.

pH: Compost pH is an important indicator of its acidity or alkalinity. The optimal pH range for most plants is between 6 and 8. Compost pH can vary depending on the initial feedstock, but well-made compost usually has a near-neutral pH that is favorable for plant growth.

Bulk density: Bulk density refers to the weight of compost per unit volume. Well-made compost usually has a moderate bulk density, which allows for good aeration and water retention in the soil when applied as a soil amendment.

Water content: Compost should have a suitable moisture content for optimal decomposition and nutrient release. The ideal water content of compost is generally around 40-60% by weight. Compost that is too dry or too wet can affect its quality and performance as a soil amendment.

Stability: Mature compost should be stable and not undergo further decomposition. It should have a uniform texture, be crumbly, and have a pleasant earthy smell. Unstable or immature compost may contain partially decomposed materials that can compete with plants for nutrients or release phytotoxic compounds.

3.1.1 C:N Ratios in Compost

One important aspect of composting is the ratio of carbon to nitrogen (C:N ratio), which plays a crucial role in the composting process and the quality of the resulting compost. The C:N ratio refers to the ratio of carbon (C) to nitrogen (N) by weight in the composting materials. The optimal C:N ratio in composting is essential for achieving efficient decomposition, proper nutrient balance, and high-quality compost (Bernal et al. 1998).

Numerous studies have been conducted to investigate the effects of C:N ratios on composting processes and the characteristics of the resulting compost. Overall, research findings highlight the significance of maintaining an appropriate C:N ratio to ensure successful composting, thus, the ideal C:N ratio for composting is generally considered to be around 25-30:1, with 25-30 parts of carbon for every 1 parts of nitrogen. This ratio provides a balanced environment for microorganisms involved in the decomposition process, promoting efficient breakdown of organic materials (Hussain & Hait 2022).

When the C:N ratio is too high (i.e., excess carbon compared to nitrogen), the composting process may be slow, and the decomposition may be incomplete. This is because microorganisms require nitrogen as a nutrient source for their growth and metabolism, and inadequate nitrogen can limit their activity. On the other hand, when the C:N ratio is too low (i.e., excess nitrogen compared to carbon), the composting process may become overly rapid, leading to the loss of nitrogen in the form of ammonia gas, resulting in a loss of nutrients and reduced compost quality (El-mrini et al. 2022). In addition to the optimal C:N ratio, other factors such as temperature, moisture, aeration, and pH also play important roles in composting. These factors can interact with C:N ratios and affect the composting process and the quality of the resulting compost. Therefore, it is crucial to consider the C:N ratio in combination with other parameters when designing and managing composting systems.

3.1.2 Composting Process

The existence of populations of microorganisms presents in the composting process as well as the rate at which organic waste is transformed must be ensured and controlled to produce compost. These characteristics include temperature, humidity, aeration, pH, and C:N ratio. According to the Food and Agriculture Organization of the United Nations (2015), the following are the four stages of the composting process (Fig. 1Figure 1):

Mesophilic phase: in this first step, the microorganisms start the adaptation process in the medium and they start to proliferate using the carbon and nitrogen sources available, after two to eight days, the temperature start to increase between 50°C and 70°C and the pH of the mixture falls to levels near 4 as a result of the breakdown of organic molecules into organic acids.

Thermophilic phase: when a temperature of 40°C is reached, as a second step the thermophilic bacteria take the place of the mesophilic microbes, due to those microorganisms having the ability to quickly degrade the material by breaking down complicated carbon sources like cellulose and lignin as well as waxes and complex proteins, the temperature reaches 70°C and pH is rising up to around 8. This process is also called hygenitazion phase, since during this time the pasteurization process takes place, and all harmful bacteria like Salmonella sp., Escherichia Coli, and fungal spores are eliminated. It is necessary to air the mixture periodically, due to the microbes needing oxygen during the process.

Cooling: when all the material is transformed, the temperature again drops to 40°C, mesophilic bacteria reemerge and continue to break down polymers like cellulose and lignin, therefore the mixture's pH drops again, and over time, the pH stabilizes and the oxygen demand decreases.

Maturation phase: this final phase corresponds to a slow fermentation in which the less biodegradable portion of the organic matter is broken down. Here, new chemical reactions take place, such as the condensation and polymerization of carbon compounds, new acids are created, and new molecules are solidified. The temperature stabilizes with the environment and the pH has a neutral value of 7, allowing the emergence of new populations of bacteria, mites, and insects that will be responsible for finishing the transformation of the compost.

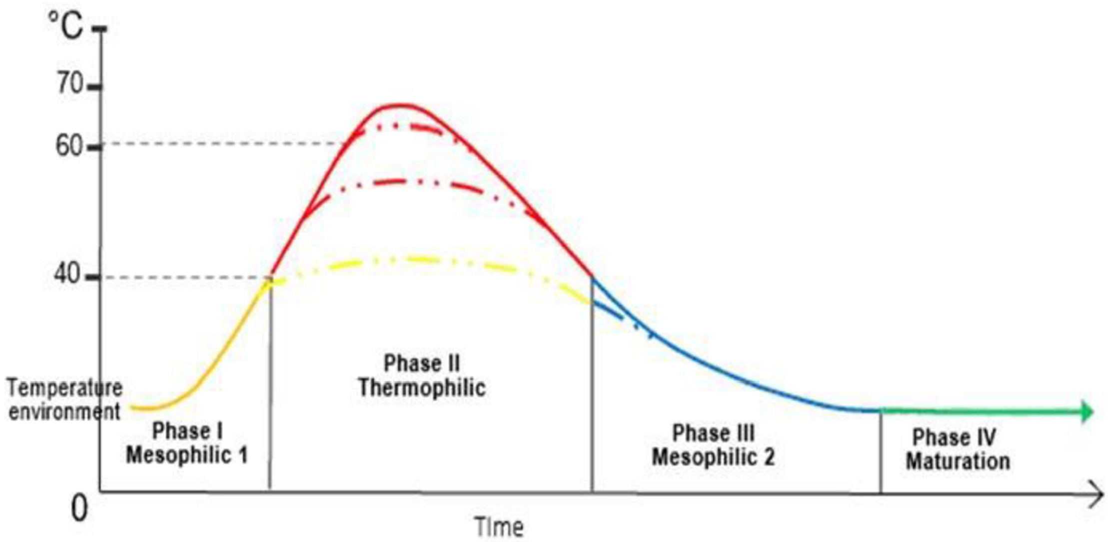

Figure 1. Stages of the Composting Process.
Source: https://opanatura.com/compost-and-composting/

As a result of the composting process, stable and matured compost is produced, which can be used as a valuable soil amendment in agriculture. Compost that has undergone proper decomposition and maturation is characterized by its nutrient-rich content, balanced pH, moderate bulk density, suitable moisture content, and stability. These qualities make it a valuable addition to soils, as it can enhance soil fertility, structure, and water retention, and provide essential nutrients for plant growth. Well-made compost can also improve soil biodiversity and promote healthy microbial activity, contributing to overall soil health and sustainability in agricultural practices (Reinikainen & Herranen 2001; Wichuk & McCartney 2010).

3.1.3 Application Methods of Compost as Soil Amendment

There are two main methods of applying compost to agricultural land: incorporation into the soil and surface application. Both methods have their advantages and disadvantages, and the choice of which method to use depends on various factors such as soil type, crop type, and compost quality (Szmidt 2001). In first place, incorporating compost into soil involves the activity of mixing the compost into the soil before planting, for that reason, this method ensures that the nutrients and organic matter in the compost are distributed throughout the soil, making them available to plant roots. Studies have consistently shown that incorporating compost can significantly improve soil fertility, increase water holding capacity, and improve soil structure(Chan et al. 2007a, 2007b; Giannakis et al. 2014). These benefits can lead to increased crop yields and better plant health (Aytenew & Bore 2020).

Although incorporating compost in the soil offers several benefits, there are also some potential disadvantages to this method (Sikora 1998). One of the primary disadvantages is the increased labor and time required, particularly for larger farms, in addition, if the compost is not properly decomposed, it may attract pests and pathogens that can harm crops, posing a risk to crop health and yield. Improperly aged or balanced compost may also contain high levels of certain nutrients, such as nitrogen, which can lead to nutrient imbalances in the soil and negatively impact plant growth.

Surface application, on the other hand, is a method of applying compost to the soil by spreading it on the soil surface without incorporating it into the soil. This method can be faster and less labor-intensive than incorporating compost, making it a popular choice for large-scale agricultural operations. Surface application can improve soil structure and increase water holding capacity, as shown in the study conducted by Agassi et al. (1998). On the other hand, surface application can also increase the soil organic matter content, which can lead to improved soil fertility and crop yields, this was demonstrated in the study conducted by Cox et al. (2021), which found that surface application of compost significantly improved crop yield and nutrient uptake in Chinese cabbage and papaya crops, making it a recommended method for perennial orchards to avoid damaging surface roots.

3.1.4 Benefits of compost in soil

The use of compost in soil contributes to improve its physical, biological, and chemical characteristics. The European Compost Network (2019), an entity that promotes sustainable practices, establishes some soil parameters that are directly influenced by the use of compost, those are: bulk density, water holding capacity, aggregate stability, and penetration resistance. Also, the use of compost can contribute to the retention of carbon in soils as well, to the reduction of compaction by improving the stability of the aggregates.

Some studies agree that compost has a lower density than the mineral fraction of the soil; therefore, incorporating compost into the soil results in a significant increase in porosity, improving structure and reducing the bulk density. As mentioned by Kranz et al. (2020), increasing the organic matter content in soils after compost application also increases the radius of the pore spaces, thus decreasing the bulk density and compaction rates, likewise the decrease in bulk density leads to a better functioning of the reticular system of plants, since not being a compacted soil there is greater root growth as well as water and nutrient transport.

On the other hand, the water holding capacity of soils depends directly on porosity and structure of the soil (Abdallah et al. 2021) thus, each soil type has different capacities to retain water, air and nutrients. In general terms, sandy soils have high levels of drainage and aeration due to the large spaces between the particles, likewise sandy soils have a reduced capacity to retain water and nutrients. On the other hand, clay soils have lower levels of drainage and aeration than sandy soils, due to the small size of the particles, as well as the small spaces between them; this type of soil retains large quantities of water and nutrients at the same time. In the case of loamy soils, it is possible to determine these types of soils have better characteristics since they have optimal drainage and aeration levels due to the optimal particle size distribution and pores.

In this way, many studies have shown that the use of compost in different soils significantly increases the water retention capacity as a direct consequence of the improvement in the soil structure, since the addition of organic matter endorses the improvement of the clay-humic fraction of the soil and the stability of aggregates (Bouajila & Sanaa 2011).

Soil can be defined as a complex system primarily made up of rock fragments left over from erosive processes and other physical and chemical changes, as well as organic matter produced by biological activity on it.

It is necessary to present different points of view to give an exact definition of soil; i) from a geotechnical perspective soil can be defined as an unbound material that is situated above the bedrock, ii) in civil engineering soil is the principal material used in construction, and iii) the soil, seen from the perspective of agriculture, is the layer of fertile material that covers the surface of the Earth and is tapped by plant roots to provide support, nutrients, and water, iv) any definitions from an environmental perspective involve the crucial role of the soils in several ecosystem processes, such as water regulation and distribution, etc. (DEECA 2023).

The American Society for Soil Science defines soil as the top layer of Earth that is made up of minerals and organic material and, is affected by the factors that created it such as climate, topography, biota, parent material, and time (SSSA 2023) also, the soil is a product of the alterations and interactions that these materials experience (Pan et al. 2012).

Five separate variables influence soil formation processes, according to some authors, those variables are: parent material, climate, relief, biota, and time (Buol et al. 2011). The five soil-forming factors are divided into active and passive components; therefore, it is possible to determine due to the first-hand observation of their effects on soil development, climate and biota are recognized as the active components in soil formation. On the other hand, because their effects are not immediately visible, passive elements include weather, geography, and parent material (Bockheim et al. 2014).

3.2 Physical Characteristics of the Soil

Soil system combines air and water in varying amounts as well as organic and inorganic particles in different ratios. The combination of soil-forming factors and passive elements have a significant impact on the physical properties of soil, which ultimately determine its suitability for different agricultural practices. Texture, structure, consistency, porosity, and effective depth are important physical characteristics of soil that can affect crop production (Dexter 2004). These properties determine the soil's ability to retain water and nutrients, support root growth, and provide aeration.

In the following sub-chapters, the selected soil properties investigated within the thesis, are briefly described.

3.2.1 Soil Texture

Different sized particles and mineral fractions are present in all soils therefore, soil texture is a key characteristic that is determined by the relative proportions of sand (0.05-2 mm), silt (0.002-0.05 mm), and clay (<0.002 mm) particles (Gee & Bauder 2018). It is an important property that affects many aspects of soil behaviour and functioning, such as water retention, nutrient availability, and the fixation of the root system of plants; as a result, the proportion of sand, silt, and clay particles in soil can affect factors such as carbon sequestration, water retention, and hydraulic conductivity. Soil classification based on soil texture is typically done using the percentage of sand, silt, and clay particles present in a soil sample(Anderson 2022). The proportions of these three particle sizes determine the soil's texture and influence its physical and chemical properties. The following are commonly used soil texture classes based on the percentage of sand, silt, and clay (Osman 2013):

- Sandy soils: Sandy soils are characterized by a high percentage of sand particles (typically >85%) and low percentages of silt and clay. Sandy soils have low water holding capacity, low nutrient retention, and good drainage.
- Loamy soils: Loamy soils are considered ideal for agriculture as they have a balanced proportion of sand, silt, and clay particles. Loamy soils typically have moderate water holding capacity, good drainage, and high nutrient retention. They are often fertile and easy to work with, making them suitable for various crops.
- Clayey soils: Clayey soils have high percentages of clay particles (typically >40%) and lower percentages of sand and silt. Clayey soils have high water holding capacity but poor drainage and can become easily compacted when wet. They are often heavy and sticky when wet and hard when dry, making them challenging to manage.
- Silty soils: Silty soils have high percentages of silt particles (typically >80%) and lower percentages of sand and clay. Silty soils have moderate water holding capacity,

moderate drainage, and can be easily compacted. They are often fertile and suitable for certain crops but may require management practices to improve drainage and prevent compaction.

- Sandy loam, clay loam, and silt loam: These are intermediate soil texture classes that combine characteristics of sandy, clayey, and silty soils. Sandy loam has a relatively equal proportion of sand and loam, clay loam has more clay than sand, and silt loam has more silt than sand. These classes exhibit varying water holding capacity, drainage, and fertility characteristics depending on the specific proportions of sand, silt, and clay particles.

Hillel (1998), stated that soil texture is a fundamental property that affects the physical behavior of soil. According to the author, the influence of soil texture on soil water retention is mainly due to the pore space within soil. Soil texture affects the size and distribution of pores, which determines how much water can be retained in the soil. Soils with a high proportion of fine particles (silt and clay) tend to have more pores, which results in higher water retention than coarse-textured soils (e.g., sandy soils). This is because fine-textured soils have smaller pores that can hold water against gravity, whereas coarse-textured soils have larger pores that allow water to drain more easily.

It can be inferred that from the Hillel's work that soil texture also affects hydraulic conductivity, which is the ability of soil to transmit water. Soil texture affects hydraulic conductivity by determining the size and distribution of pores in the soil. Coarse textured soils such as sandy soils tend to have higher hydraulic conductivity than fine-textured soils (e.g., clay soils) because they have larger pores that allow water to move more easily. However, the large pores in coarse-textured soils also result in less water being retained, which can be a limitation in some situations.

The interpretation of water holding capacity and water capacity supports the view that soil texture is an important factor influencing soil water retention and hydraulic conductivity. The authors note that the amount of water that soil can retain at field capacity (the amount of water held in the soil against gravity) is primarily determined by soil texture. The authors mention that fine-textured soils (e.g., clay) have a higher water-holding capacity than coarse-textured soils (e.g., sand) due to their smaller pore size, which allow them to hold more water against gravity.

In terms of hydraulic conductivity, Cassel & Nielsen (2018) also noted that soil texture is a primary determinant. The authors explain that soils with high clay content have lower hydraulic conductivity due to their fine pore size, which hinders water movement. Conversely, sandy soils have higher hydraulic conductivity due to their larger pore size, which allows water to move more freely through the soil.

In the study conducted by Lal (2004) , the effects of soil texture on soil organic carbon sequestration were examined. The author found that soils with a higher proportion of clay particles had greater potential for carbon sequestration than sandy soils. This is because clay particles provide more surface area for microbial activity and chemical reactions that promote carbon storage. Similarly, in the study by Telles et al. 2003, was examined the influence of clay content on soil organic matter (SOM) dynamics in tropical forest soils. The authors found that higher clay content was associated with increased SOM stabilization through mineral-organic matter interactions and protection against microbial decomposition, highlighting the importance of clay in SOM dynamics.

Another study by Karki et al. (2018) investigated the influence of soil texture on soil hydraulic properties. The authors found that soil texture was a major determinant of soil water retention and hydraulic conductivity. Specifically, soils with a higher proportion of clay particles had greater water-holding capacity but lower hydraulic conductivity, while sandy soils had lower water-holding capacity but higher hydraulic conductivity.

According to Natural Resources Conservation Service (2023), the soil texture could be determined by using the soil texture triangle shown in Fig. 2.

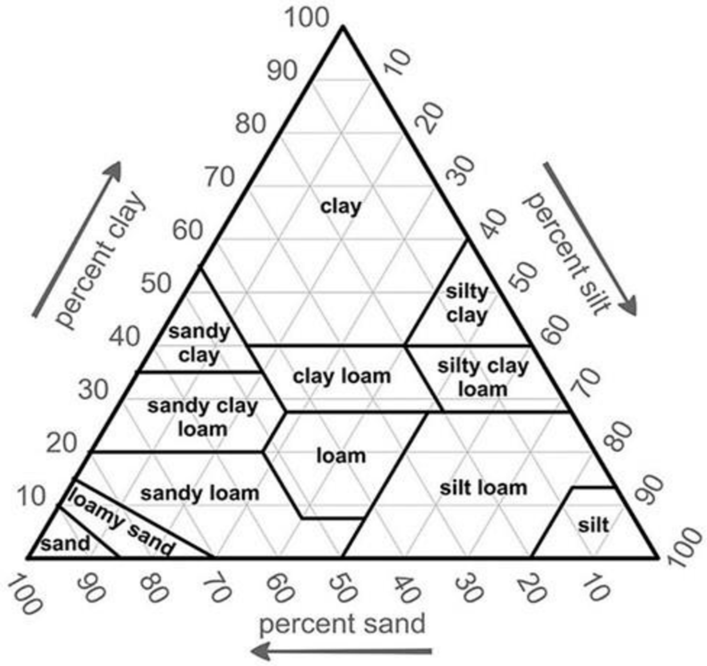

Figure 2. USDA Soil Texture Triangle.
Source: https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e06.htm

The hydraulic properties of soils are not solely determined by their texture, but also by their soil structure, as both properties play crucial roles in shaping the pore system, which affects water transport and retention in soils. Soil structure refers to the arrangement and aggregation of soil particles into larger units or aggregates, which can have a significant impact on soil hydraulic properties. Aggregates can create pore spaces that vary in size and shape, influencing the movement of water through the soil profile. Larger aggregates with well-defined pore spaces can promote better water infiltration and drainage, while smaller aggregates or compacted soils can restrict water movement and increase runoff.

3.2.2 Soil Structure

The way the constituents of soil are organized and positioned defines its structure. Sand, silt, and clay are soil constituents that clump together to create the soil aggregates (FAO 2023a). Soil structure has direct effects on various properties such as water retention and movement, erosion reduction, aeration, root penetration, and nutrient disposition to provide an optimal environment for plant root growth. Factors such as organic matter, microbial activity, and physical disturbance can affect soil structure at different levels.

Soil structure also has a critical effect in soil erosion levels, as it is known from a study led by Bronick & Lal (2005) soils with well-developed structure, characterized by stable aggregates and pore spaces, are more resistant to erosion and has greater potential for carbon sequestration than soils with poor structure.

According to Tisdall & Oades (1982), soil aggregate stability refers to the ability of soil aggregates to resist breakdown under different physical and biological stresses. Soil aggregates are composed of primary particles (such as sand, silt, and clay) held together by various physical and chemical forces, such as organic matter, iron and aluminum oxides, and calcium carbonate. The authors also introduced the concept of water-stable aggregates (WSA) as a measure of soil aggregate stability. WSA is defined by the authors as the proportion of soil aggregates that remain intact when subjected to a standardized wetting and sieving procedure. This method involves wetting the soil sample and then passing it through a set of sieves with decreasing mesh size to isolate different aggregate size fractions.

In addition, the authors also addressed the quantitative index, known as the WSA index, to express the stability of soil aggregates. The WSA index is calculated by dividing the mass of water-stable aggregates by the mass of total aggregates, expressed as a percentage. The higher the WSA index, the greater the soil aggregate stability. The authors concluded that soil aggregate stability is an important factor influencing soil structure and function, affecting soil water retention, nutrient cycling, and plant growth. They also highlighted the role of organic matter in promoting soil aggregate stability and suggested that the WSA index could be used as a useful indicator of soil quality and management practices.

Likewise, several quantitative methods for measuring soil structure based on the stability of soil aggregates can be used as predictors of soil erosion and water infiltration. For example, the method proposed by Dexter (2004), known as the slake test, involves soaking soil aggregates in water and measuring the number of fine particles that are released. With the results of the test, it is possible to predict soil erosion and water infiltration due to, if the large pores within the soil are stable, water can move into the soil without causing the aggregate to break, for that reason, stable aggregates in the soil allow better water infiltration, reduce the runoff and therefore, the erosion.

In a study conducted by Six & Paustian (2014) , the authors provide an overview of the importance of soil aggregates and associated organic matter in maintaining soil structure and function, also the authors determined that soil organic matter is essential for stabilizing soil aggregates, by acting as a binder that group soil particles together, improving soil structure and preventing erosion. A review article provided by Six et al. (2004) , gives a comprehensive overview of the relationship between soil aggregates, soil biota, and soil organic matter dynamics. The authors discuss how soil aggregates provide a habitat for soil biota and promote organic matter stabilization, which in turn improves soil aggregate stability. The review also highlights the role of different management practices, such as crop rotation and tillage, in influencing soil aggregate stability.

According Lal & Shukla (2019), soil structure can be divided into the following categories (Fig. 3):

- Single grain: sand granules do not easily link together or are disintegrated.
- Granular: it is found more resemble square clods and are a bit bigger than granular, therefore typically have many cracks and pore space.
- Prismatic: The clods have a prismatic form and are longer and thicker.
- Massive: In this instance, the structure is compacted and does not form any clods.
- Platy: the soil is composed of thin and horizontal layers.

Figure 3. Soil Structure. Source:
https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e06.htm

3.2.3 Consistency of Soils

The resistance of the aggregates to breaking, or their greater or lower propensity to grind into powder or pieces, is understood as the soil consistency (FAO 2023b). Soil consistency has a significant impact on the resistance of soil to deformation, which directly affects the root growth and soil water movement. This is demonstrated by Horn et al. (1995) who found that when a soil is very compact, it has less pore space and is more dense, causing yield loss in crop production by restricting root growth and reducing air and water circulation in the soil. They also found that the relationship between soil consistency and root growth varied depending on the species of plant and the specific soil properties.

A study conducted by Liu et al. (2023) investigated the effects of soil consistency on soil erosion and sediment transport. The authors found that soils with high consistency, such as clay soils, are more resistant to erosion than soils with low consistency, such as sandy soils. However, they also found that soil consistency affects the size distribution and transport of sediment particles.
Also, the authors address the degrees of soil consistency as:

- Loose: the soil is disaggregated.
- Soft: the soil crumbles or grinds under very weak pressure.
- Slightly hard: weakly resistant to pressure, easily broken between thumb and forefinger.
- Hard: moderately resistant to pressure. Can be easily broken by hand, but difficult to break between thumb and forefinger.
- Very hard: very resistant to pressure and difficult to break with the hands.
- Extremely hard: Extremely resistant. Cannot be broken by hand.

The relationship between soil moisture, soil consistency, and various soil parameters such as liquid limit, plastic limit, index of consistency, and index of plasticity has been extensively studied in the fields of civil engineering and agriculture. These parameters are crucial in understanding the behavior of soils and their hydraulic properties, particularly in the context of shrinking and swelling soils.

Several studies have highlighted the importance of soil consistency parameters in civil engineering and agricultural applications. In civil engineering, these parameters are used to assess the suitability of soils for construction purposes, such as determining the stability of foundations, embankments, and slopes. Soil consistency parameters also play a significant role in predicting the settlement and deformation characteristics of soils, which are critical for the design and construction of infrastructure projects (Coduto et al. 2016).

In agriculture, soil consistency parameters are equally important for understanding soil behavior and managing agricultural lands effectively (Field & Long 2018). Soil moisture content significantly influences soil consistency and has a direct impact on the availability of water and nutrients to plants, root growth, and overall crop productivity. For instance, in areas with shrinking and swelling soils, changes in soil moisture content can lead to soil cracking, heaving, and other undesirable soil behavior, which can impact plant growth and yield. Understanding the relationship between soil moisture and soil consistency is crucial for optimizing irrigation practices, nutrient management, and crop production.

3.2.4 Soil Porosity

The soil space that is not occupied by solids is called the soil pores, which are directly dependent on soil texture and structure, resulting in a bulk density, and determine plant root growth and air and water dynamics within the soil profile. It is possible to determine two kinds of pores: macropores and micropores. The macropores, which cannot hold water against gravity, allows aeration and drainage of the soil as well as serving as the primary area for root development. The micropores are those that store water, some of which is accessible to plants. The sum of macropores and micropores determines the soil porosity, also known as pore (Luxmoore 1981).

It is worth mentioning that soil texture and structure influence soil porosity. Soils with a high clay content typically have smaller pores, while soils with a high sand content have larger pores, therefore, good soil structure allows more macropores and improves soil function, while poor structure can lead to soil compaction and reduce soil porosity (Brady & Weil 2016).

As is mentioning in the previous chapter, soil texture refers to the size of soil particles and their distribution within the soil, therefore, soil with a higher percentage of fine particles, such as clay, will have a smaller pore space and lower porosity compared to soil with more coarse particles, such as sand. This is because fine particles tend to pack more tightly together, leaving less space for pores. Regarding soil structure, on the other hand, refers to the arrangement of soil particles into aggregates. Soil with a better structure will have larger aggregates, which create larger pore spaces, leading to higher porosity. Poor soil structure, such as that caused by compaction, can reduce pore spaces, leading to lower porosity (Bronick & Lal 2005).

Other important facts to consider is that when compost is added to soil, it can help to improve soil fertility and promote the growth of beneficial microorganisms in the soil. As these microorganisms break down the organic matter in the compost, they create channels and pathways within the soil. These channels and pathways are called macropores and mesopores, and they help to increase soil porosity. Macropores are larger openings in the soil that are typically created by the activity of earthworms, insects, and other soil-dwelling organisms. Mesopores are smaller openings that are formed by the decomposition of organic matter in the soil. Both types of pores are important for soil aeration, drainage, and water retention (Koishi et al. 2020).

According to Koishi et al. (2020) , in addition to creating pores, the decomposition of organic matter in compost can also help to improve soil structure. As the organic matter decomposes, it releases a substance called humus, which helps to bind soil particles together into aggregates. These aggregates help to improve soil structure by creating more stable pore spaces and increasing soil stability.

On the other hand, some agricultural practices, such as tillage, organic matter addition, and cover cropping, can influence soil porosity. Excessive tillage and compaction can reduce soil porosity and lead to soil degradation, while practices such as cover cropping and the addition of organic matter can improve soil structure and increase porosity, thus, Tisdall & Oades

(1982), The authors emphasize the importance of maintaining good soil structure and porosity for sustainable agriculture and soil conservation.

3.3 Soil Water Content

Soil water content is an important parameter for many environmental and agricultural applications. For example, in agriculture soil water content is determinative for irrigation management and nutrient availability. In soil hydrology, soil water content is necessary for modelling water movement in soil and to predict some flood events. It is worth mentioning that soil water content is affected by several factors, including precipitation, evapotranspiration, soil texture, and structure which also affect water movement in the soil and plant (Miyazaki 2005).

In other words, soil water content is a crucial factor for plant growth, ecosystem functioning, and sustainability. Adequate soil water content is necessary for plants to grow and directly affects the availability of plant nutrients in the soil. Changes in soil water content can also impact soil physical and chemical properties, such as soil structure, nutrient cycling, and microbial activity, which can further affect plant growth and ecosystem functioning.

In a study conducted by EI-Maghraby et al. (2011), the effect of adding compost on soil moisture retention in a sandy loam soil was investigated. This study demonstrated that the addition of compost to a sandy loam soil increased soil water content, retention capacity, and reduced water loss. The authors explain the fact that compost contains organic matter, which improves soil structure and water-holding capacity. The organic matter in compost acts like a holding material, which releases water slowly over time, thus preventing water from a rapid infiltration and runoff from the soil surface. As a result, the soil water content and availability for plants to use is increased.

Moreover, the authors address the improvement in soil structure due to the addition of compost can reduce soil compaction, which can further improve soil water retention capacity. Additionally, the organic matter in compost can enhance soil microbial activity, which can improve nutrient cycling and organic matter decomposition, leading to increased soil fertility and plant growth.

There are many methods for soil moisture content determination; direct gravimetric method and a number of indirect methods that relates the measured property (e.g. time, relative permittivity, resistance, etc.) with the soil moisture content. Recent progress in the measurement methods is described in the following sub-chapter.

3.3.1 Recent Progress in Soil Water Content Measurement

Measuring soil water content provides valuable information for irrigation management, nutrient availability, hydrological modelling, and climate modelling. A number of techniques are available for measuring soil water content, including the gravimetric method, neutron probe, time domain reflectometry (TDR), and capacitance sensors, hence, each measurement method has different size reaching to different depths and offers certain level of accuracy, precision, and resolution for measurement within a particular volume of soil (Campbell et al. 2018).

Aerial soil moisture content monitoring using remote sensing methods has gained significant attention as a topical issue in various fields, including agriculture, hydrology, and climate research. Remote sensing techniques, such as satellite-based or airborne sensors, provide a non-destructive and cost-effective means to measure and monitor soil moisture content over large spatial areas and temporal scales. These methods allow for frequent and real-time monitoring of soil moisture, which can aid in improving agricultural management practices, water resource management strategies, and weather/climate prediction models. For example, studies by Wagner et al. (2012) and Kornelsen & Coulibaly (2013)shown the potential of remote sensing-based soil moisture monitoring in improving irrigation scheduling and enhancing crop yield.

Recent progress in soil water content measurement has been an active area of research in soil science and hydrology. Soil water content is a key parameter that affects various soil processes, including plant growth, nutrient transport, and soil erosion. Accurate and efficient measurement of soil water content is critical for water resource management, climate change adaptation, and sustainable agriculture. Various methods have been developed and improved for soil water content measurement, including gravimetric method, time domain reflectometry (TDR), capacitance sensors, and neutron probes. However, there are still challenges in achieving reliable and representative soil water content measurement under different soil and environmental conditions.

In a study conducted by Rasheed et al. (2022), the authors provide a comprehensive overview of the latest research progress in soil water content measurement, including the principles and characteristics of different methods, the advantages and limitations of different sensors, and the application of advanced technologies such as machine learning and wireless networks. The authors also discuss the future direction and challenges in soil water content measurement, such as improving accuracy and precision, reducing sensor errors and uncertainties, and integrating different methods for comprehensive soil water monitoring. The authors conclude that, in order to identify the best soil moisture technique with the highest accuracy, the value selection method (VSM) is the recommended approach also, the neutron probe is the preferred option over the FDR or TDR sensor for soil moisture measurement. Neverteless, for large-scale monitoring of soil moisture with high spatiotemporal resolution, remote sensing techniques have fulfilled this requirement thus, machine-deep learning approaches can measure and predict soil moisture even in data-scarce regions by leveraging their self-learning capabilities.

3.4 Water Movement in Soils

Soil hydraulic conductivity concept refers to the soil ability to transmit water through its pores and is a critical parameter in many hydrological and environmental studies. The knowledge of soil hydraulic conductivity is necessary for understanding soil-water interactions, therefore, is important for a wide range of applications, including agriculture, engineering, and environmental sciences (Sposito 2016). For example, this concept is mainly used in agriculture to optimize irrigation practices and to assess the potential for waterlogging or soil erosion. In engineering, it is used to design drainage systems and to evaluate the potential for soil subsidence. In environmental sciences, it is used to model the movement of water and contaminants through the soil and to assess the potential for groundwater contamination.

Gravitation, capillary rise, matric, groundwater, osmotic, pneumatic and envelope and osmosis are the mechanisms that cause water movement through soil profile. Water moves through the soil at different suction pressures and under different mixtures of components like air-water, causing the saturation flow and the unsaturated flow. It is important to note that there are primarily two types of forces which determine the movement of water in the soil profile: the gravity, which tends to carry the water to deeper strata and, the suction forces which keep the water in the pores; as a result, if the suction forces predominate, the water is retained into the soil profile, although if the force of gravity is stronger, the water moves downwards (Brady & Weil 2016).

The hydraulic conductivity of soil is affected by a few factors, including the soil texture, soil structure, porosity, and soil moisture content. Soil texture, for example, influences the hydraulic conductivity by affecting the size and distribution of soil pores. Soils with larger pores tend to have higher hydraulic conductivity values, while soils with smaller pores tend to have lower values. Soil structure also affects hydraulic conductivity by influencing the continuity and connectivity of soil pores. Soils with well-developed aggregates, for example, tend to have higher hydraulic conductivity values than soils with poor structure. In addition, the moisture content of soil has a significant effect on hydraulic conductivity. As the soil becomes more saturated, the hydraulic conductivity tends to decrease due to the reduction in air-filled pore space, while as the soil dries out, the hydraulic conductivity tends to increase due to the increase in air-filled pore space (Tuller & Or 2001).

The saturated hydraulic conductivity is commonly denoted "K”, and its units are length per time. This means that it represents the rate of flow of water through a unit cross-sectional area of a porous medium under a unit hydraulic gradient. The unit of length used in the measurement of hydraulic conductivity could vary depending on the system of units being used, such as meters or centimeters, and similarly, the unit of time could be expressed in seconds, minutes, or hours. Therefore, the units of hydraulic conductivity could be written as meters per second (m/s), centimeters per hour (cm/h), or meters per day (m/day), among others (Lal & Shukla 2019).

According to the authors, the most used definition of hydraulic conductivity is based on Darcy's Law (Eq. 1), which states that the volume of water per unit of time passing through a unit of area in porous medium is proportional to the hydraulic gradient. Therefore, the units reflect the relationship between the rate of flow, the cross-sectional area, and the hydraulic gradient, and can be used to compare the hydraulic conductivity of different porous media or to estimate the flow rate of water in a particular system. Mathematically, it can be expressed as:

$$v = K\frac{\Delta h}{L} \qquad \text{(Eq. 1)}$$

Where Δh = water level difference (m)
L = length of the flow in flow direction (m)
K = saturated hydraulic conductivity (m/s)
v = velocity (m/s)

Depending on the amount of water present in the soil, the water moves within the fully saturated media or in some pores water was replaced by air and water moves within an unsaturated media. For the second case, the hydraulic conductivity is called unsaturated and can be expressed as a function of soil moisture content or as a function of pressure head k(h) (Hillel 1998). To better understand water movement in soil, Fig. 4 displays an illustration of water movement in a porous medium such as soil:

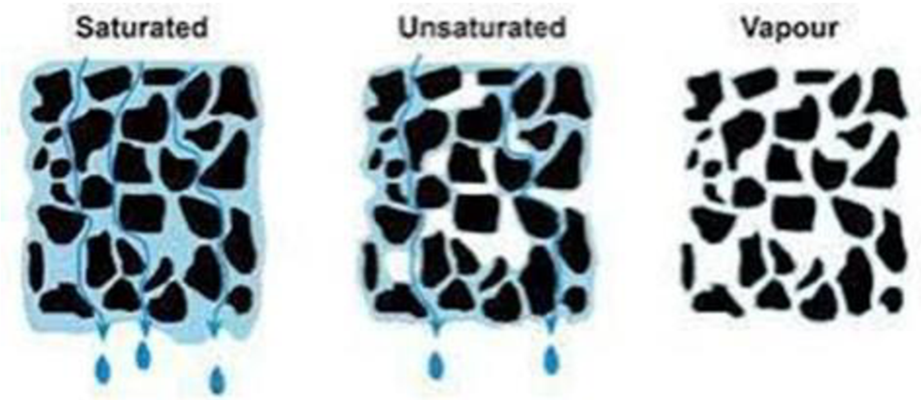

Figure 4. Water Movement in Soil.
Source: http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1996

3.4.1 Saturated Hydraulic Conductivity

Saturated hydraulic conductivity is defined as the hydraulic conductivity of a porous medium when it is completely saturated with water. It is a fundamental property that is used to characterize the permeability of soil, rocks, and other porous materials (Tuller & Or 2001). As previously mentioned, the physical properties of soil play a direct role in determining the value of saturated hydraulic conductivity. Factors such as soil texture, structure, compaction, and organic matter content impact the movement of water through the soil profile, and therefore have a direct influence on the value of saturated hydraulic conductivity. These physical characteristics can impact the size, connectivity, and shape of the pores within the soil, which in turn affect the ability of water to flow through the soil.

According to Brady & Weil (2016), soil texture has been found to be one of the most important factors, one general example addresses sandy soils generally exhibiting higher hydraulic conductivity than clay soils. This is due to the larger pore spaces and greater connectivity between pores in sandy soils. However, other factors such as soil structure, compaction, and organic matter content can also play a significant role in determining hydraulic conductivity.

Saturated hydraulic conductivity can be measured in the field and in the laboratory conditions. Different techniques, including the falling head method and the constant head method can be applied (McKenzie et al. 2019). The falling head method involves measuring the time required for a column of water to fall a certain distance through a soil sample (Fig. 5), which is best suited for is applied for soils which are less permeable, and their K value is small (Pedescoll et al. 2011). According to the same authors, the falling head method has several advantages over other methods of measuring hydraulic conductivity, such as the constant head method. It is easier to set up and requires less equipment, making it more practical for laboratory use. On the other hand, the constant head method, involves measuring the flow rate of water through a soil sample under constant hydraulic head, this method is more accurate than the falling head method and is better suited for soils with relatively high K (Knappett & Craig 2012).

Each of these methods has advantages and limitations, and the choice of method depends on the specific properties of the soil being studied and the accuracy required for the application at hand. Understanding the strengths and weaknesses of each method is crucial for making informed decisions and ensuring accurate measurement of saturated hydraulic conductivity.

Soil organic matter (SOM) can have a significant impact on soil hydraulic properties, affecting hydraulic conductivity, water retention, and water movement. Many studies have shown that the addition of organic matter to soil can increase saturated hydraulic conductivity, as soils with higher SOM content generally exhibit greater hydraulic conductivity due to increased soil porosity and larger soil pore size, also the improved porosity and pore size in soils with higher SOM content result from the binding of organic matter with soil particles, leading to the creation of stable soil aggregates that enhance the soil's ability to conduct water (Hollis et al. 1977; Rawls et al. 2004).

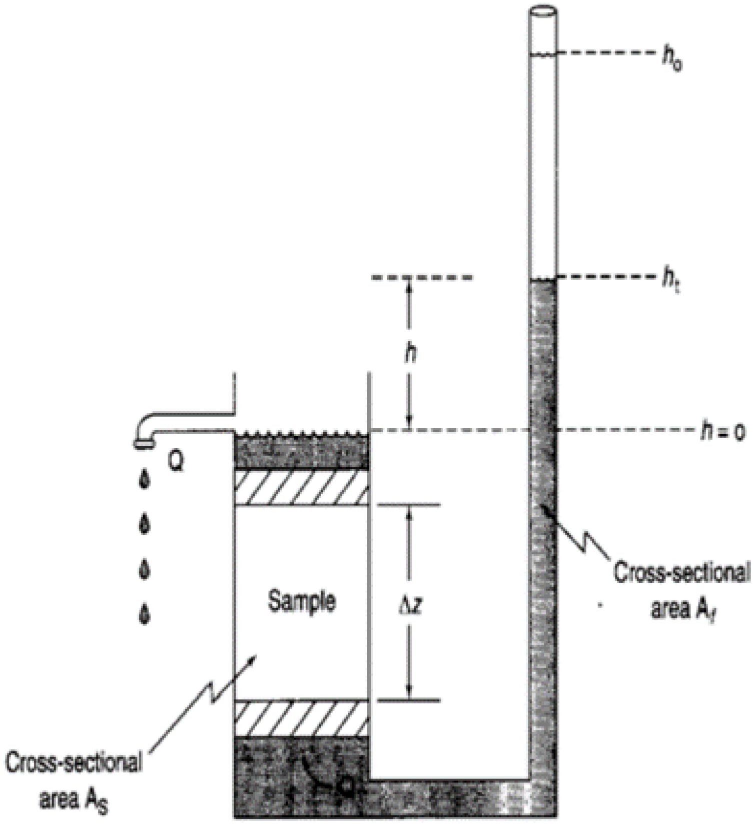

Figure 5. Falling-Head Permeameter.
Author: Todd, D.K., Mays, L.W. 2005. Groundwater Hydrology.

Unsaturated hydraulic conductivity is the other important parameter in soil hydrology, as it describes how easily water can move through soil under unsaturated conditions, it refers to a situation where the pores of the soil contain both air and water, but the amount of water present is less than the amount required to fill all the available pore space (Flint & Flint 2018). This parameter is influenced by many factors, such as soil texture, bulk density, porosity, and the distribution of pore sizes in the soil, therefore, accurate estimation of unsaturated hydraulic conductivity is crucial for many applications, including irrigation, groundwater recharge, and crop yield modeling.

There are several direct and indirect methods available for measuring or estimating unsaturated hydraulic conductivity in soil (Taibi et al. 2009). While direct methods such as the pressure chamber and steady-state methods can provide accurate measurements of this parameter, can be challenging to conduct due to the difficulty in creating and maintaining unsaturated conditions in the soil during measurement. This is principally because the degree of soil saturation can change rapidly and unpredictably under various environmental conditions such as rainfall, evapotranspiration, and soil disturbance (Hillel 1998).Therefore, indirect methods such as infiltration measurements under unsaturated conditions, and soil water retention curve are often used to estimate unsaturated hydraulic conductivity. These indirect methods are often easier and less expensive than direct measurement methods, but they still require careful calibration and validation to ensure accuracy (Ankeny et al. 1991).

4 Methodology

The following soil properties were studied in this thesis: saturated hydraulic conductivity on core samples, aggregate stability and in addition some basic physical and chemical properties such as particle size distribution, soil water content, dry bulk density, porosity, pH, electrical conductivity and organic matter content were determined.

Both disturbed and undisturbed samples (Kopecky's rings of 100 cm^3 and 250 cm^3) were taken several times during the year 2022 at three localities with different compost treatments, comparing the parcels where compost was applied onto the soil surface with control parcels without compost treatment. Only surface layer was investigated.

Samples were taken to the laboratory of soil physics belonging to the Department of Water Resources. Disturbed samples were spread on paper sheets and air-dried (larger pieces were gently crushed by hand, stones, roots etc. were removed) while undisturbed samples were weighed and stored in fridge until the time of analysis.

4.1 Study areas

The three localities were selected in the frame of the related project. Farms in Jevíčko (B) and Velké Hostěrádky (C) provided their fields for experiments of the field trial type, operated by standard machinery. The size of the experimental parcels was about 30x120 m, and on both localities was one parcel treated by compost and one parcel as control. At the Plant Production Station in Prague-Uhříněves (U) was a small parcel type of experiment with five parcels altogether, two as control and three treated with compost. The localities are shown on Fig. 6 and basic information is provided in Tab. 1.

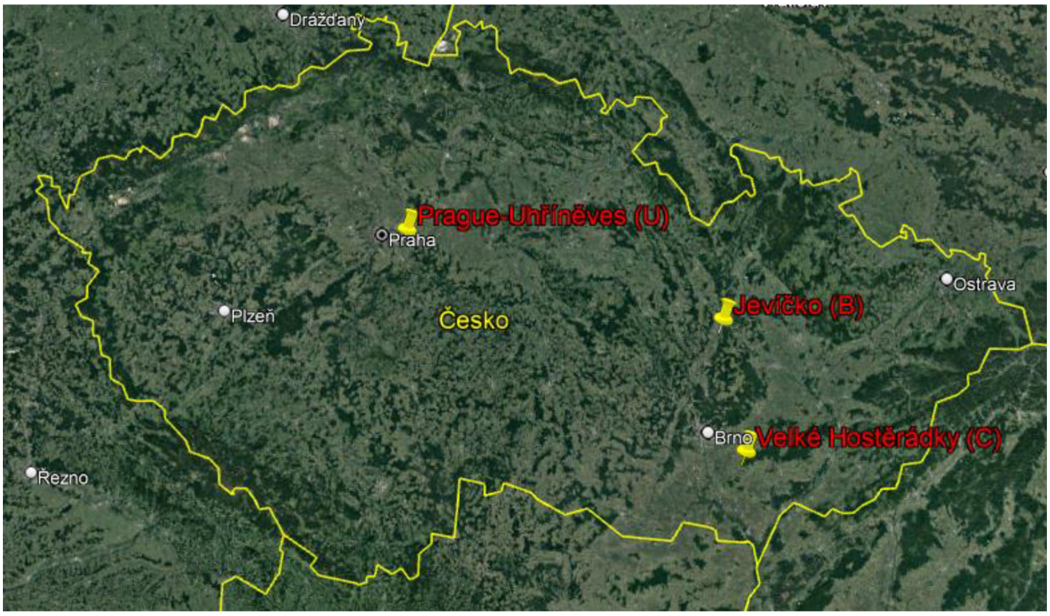

Figure 6. Study locations. Source: Google Earth.

Table 1. Overview of the study areas.

Locality	Jevíčko	Velké Hostěrádky	Prague-Uhříněves
Sample labelling	B	C	U
Type of experiment	Field trial	Field trial	Small parcels
Size of experimental parcel	3600 m^2	3600 m^2	1.2 m^2
Crop	Maize	Oat	Spring wheat
Compost treatment	200 t/ha	20 t/ha	20 t/ha
Compost application	Early spring before seeding	During vegetation	During vegetation
Date of sampling	28 Feb 2022 8 Jun 2022 4 Aug 2022	24 Mar 2022 9 Jun 2022	16 Aug 2022
Soil texture class	silty clay loam	silty clay loam	silt loam
Soil type	cambisol	chernozem	haplic luvisol

Locality Jevíčko (B)

A representative plot was selected in the field, then it was divided into two parcels, one of them the control parcel without compost and the treated parcel with compost. In both parcels were located four water content sensors altogether and near to those sensors, or in a longitudinal transect between them, soil samples were taken. First sampling was carried out on 28 February when the compost was applied on the soil surface in an extreme dose 200 t/ha (see Figs. 7 and 8). Five disturbed samples were taken from control parcel in a transect for aggregate stability determination and other analyses. Second sampling was carried out on 8 June, when maize was small, and in total twenty-four undisturbed soil samples were taken into Kopecky rings, 12 pc of 100 cm^3 and 12 pc of 250 cm^3, half from the compost parcel and half from the control parcel, for determination of saturated hydraulic conductivity. Four mixed disturbed samples from surface layer were taken around the sensors. Third sampling was carried out on 4 August, when the maize was fully grown. Undisturbed and disturbed samples were taken in the same schedule.

Locality Velké Hostěrádky (C)

The farming system at this farm is organic agriculture. The experimental setup was very similar to Jevíčko, that means, a control parcel without compost and a treated parcel with compost, sampling places near the soil water content sensors and in between in a longitudinal transect. Compost was applied on 5 May to the green oat in the dose 20 t/ha and sampling was carried out on 9 June. sampling schedule was the same as in Jevíčko.

Figure 7. Compost application on the selected parcel in Jevíčko.
Author of the photo: Dr. Jiří Souček, VÚZT.

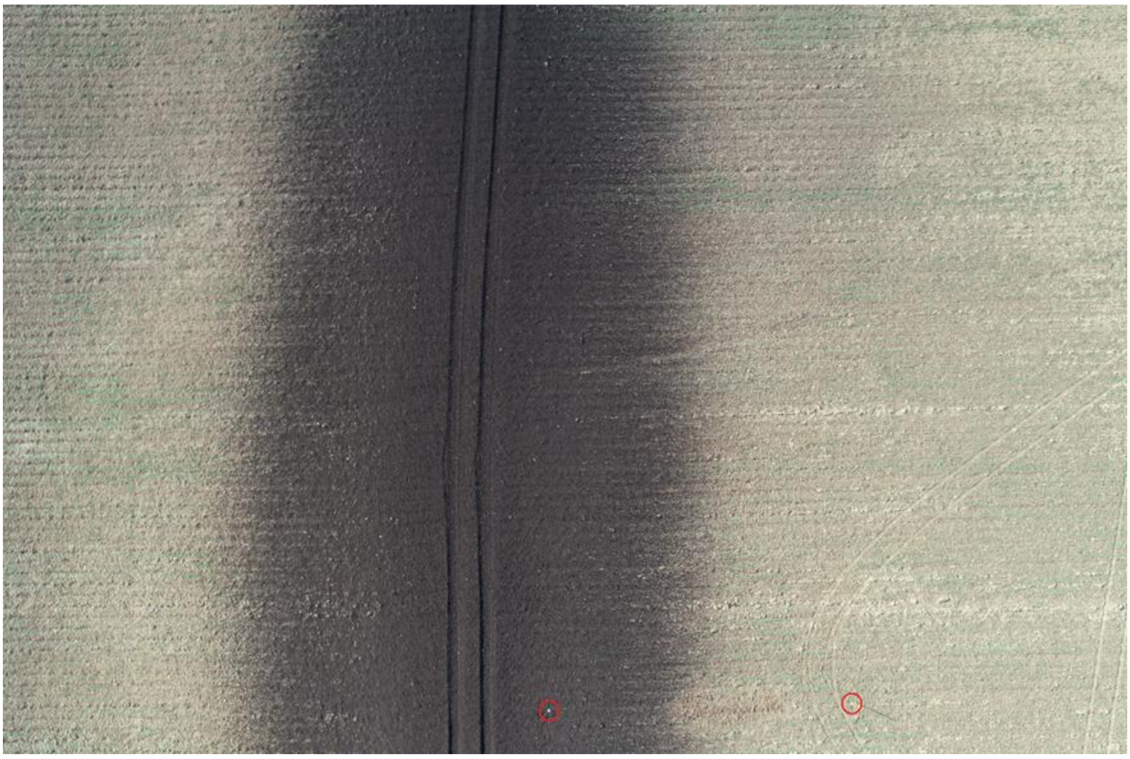

Figure 8. Parcel treated by 200 t/ha of compost in Jevíčko. Red circles show the placement of sensors/representative sampling points. Author of the photo: Dr. Jiří Souček, VÚZT.

Locality Uhříněves (U)

Small parcel type of experiment was carried out to ensure better control of environmental conditions. Five parcels were located in a row alternating control and compost treatments (see Tab. 2). The composts used were the same as in the field trials. (Locality A, Blatnice, was not independently observed in this thesis due to late compost application, which took place after vegetation season 2022, thus it is not further mentioned). Sampling was carried out on 16 August after harvest of the spring wheat.

Table 2. Experimental setup and sampling schedule in Prague-Uhříněves locality

Parcel No.	Treatment*	Sample No. (Ring 100 cm^3)	Sample No. (Ring 250 cm^3)
1	Compost (B)	Uhr 1	Uhr 7
2	Control	Uhr 2	Uhr 8
3	Compost (A)	Uhr 3	Uhr 9
4	Control	Uhr 4	Uhr 10
5	Compost (C)	Uhr 5	Uhr 11

**Composts from different localities: A – Blatnice, B- Jevíčko, C – Velké Hostěrádky.*

4.2 Compost used in experiments.

At each field trial locality, a different compost was used, produced in a local composting plant. The quality and stability of the produced compost in economically feasible distance was one of the factors for experimental sites selection in the related project. Thus, the composts used meet the quality criteria for applying compost to agricultural land.

The ratio C:N was 13:1, 6:1 and 12:1 at localities A, B and C, respectively. Composts A and C are balanced, compost B has an excess of nitrogen. Ratio $N\text{-}NH_4/N\text{-}NO_3$ serving as one of the compost maturity indicators was in all composts evaluated as matured. Overall stability was evaluated as stable for B and C, and non-stable for A (Badalíková et al. 2023).

4.3 Measurement of the soil saturated hydraulic conductivity on the falling head permeameter.

The determination of saturated hydraulic conductivity (K) was done by using the falling head permeameter, commercial product KSAT (METER Group, Inc.), see Fig. 9. The undisturbed samples (250 cm^3) after taking them out from fridge were saturated by gradually submerging them under water in controlled conditions, avoiding trapping air bubbles inside, for approximately 48 hours.

Once the samples were fully saturated, they were installed in the permeameter cell, ensuring that there were no air gaps. The initial water level in the standpipe was recorded, and then the valve was opened to allow water to flow through the soil sample. The time taken for the water level to drop by a certain amount (usually 11 cm) was recorded as the test started.

The test was repeated three times on each soil sample to ensure accuracy, and the average K was calculated. All data, including sample description, test conditions, and calculated K values, were recorded. The values of K were calculated by the device's software, employing the Darcy's law (eq. 1 in chapter 3).

Figure 9. KSAT (METER Group, Inc.).
Author of the photo: Marley Whanda Figueroa Jiménez.

4.4 Soil water content determination: Gravimetric method

For the determination of soil water content, soil samples were collected from the field using Kopecky's rings of 100 cm^3. Firstly, the soil samples were weighed in the day of sampling, and the values were recorded. The soil samples were then placed in a drying oven at a temperature of 105°C for 24 hours. After this process, the samples were removed from the oven and finally the samples were weighed again, and values were recorded.

The soil water content was calculated using the following equation (Eq. 2):

$$\theta = \frac{V_w}{V_t} \quad \text{(Eq. 2)}$$

where θ is the soil water content by volume, V_w is the volume of the water in sample (cm^3) and Vt is total volume of the soil sample (cm3). Consequently, other soil physical properties were determined, such as dry bulk density and porosity. Particle density of the value 2.65 g/cm^3 was used for calculation of porosity.

4.5 Aggregate Stability Determination: Wet sieving apparatus

The wet sieving apparatus (Eijkelkamp) (Fig. 10) was used to determine aggregate stability, based on the principle that unstable aggregates would disintegrate more easily when submerged in water compared to stable aggregates. The procedure involved filling 8 sieves, with a specific amount of soil samples of 4 g each one, of the size between 2 and 5 mm, and placed into water-filled cans. The cans were then moved up and down for predetermined duration of 3 min using the apparatus. Unstable aggregates broke down and passed through the sieve, collecting in the can underneath.

After the fixed time, the cans were replaced with new sodium hexametaphosphate-filled cans, and all aggregates were now completely disintegrated. Only sand grains and plant roots remained on the sieve, and only the aggregates were taken into consideration. After drying the cans with the aggregates, the weight of both stable and unstable aggregates was determined by dividing the weight of stable aggregates by the total aggregate weight, an index for aggregate stability was calculated.

The fraction stable is equal to the weight of soil obtained in the dispersing solution cans divided by the sum of the weights obtained in the dispersing solution cans and distilled water cans, as the following equation (Eq. 3).

$$WSA = \frac{WDS}{WDS+WDW} \qquad \text{(Eq. 3)}$$

Figure 10. Wet Sieving Apparatus (Eijkelkamp).
Author of the photo: Marley Whanda Figueroa Jiménez.

4.6 Particle Size distribution analysis

Particle size distribution (PSD) analysis was determined in order to characterize the experimental fields. Hydrometer method according to standard CEN ISO 17892–4 (2017) was used. Analysis was carried out for representative samples taken close to the sensors' placements as described in chapter 4.1. Four samples were determined for Jevíčko and Velké Hostěrádky, and one sample for Uhříněves (Fig.11).

Figure 11. Hydrometer method.
Author of the photo: Marley Whanda Figueroa Jiménez.

4.7 Soil chemical properties

Modified Walkley–Black method, particularly wet combustion according to (Nelson & Sommers 1982) was used to determine soil organic matter (SOM) content. Electrical conductivity (EC) and active pH were measured in the filtrate (ratio 1:5). Only B and C localities were determined; B locality was sampled three times and C locality two times as indicated in Tab. 1. First sampling was done before compost application in both cases.

Note: Both PSD and chemical properties analyses were determined as a teamwork with contribution of the author of the thesis.

5 Results

The results of the thesis present in the next subchapters, revealed important insights into various soil properties after the application of surface compost. The findings shed light on the hydraulic behavior and structural stability, providing valuable information for understanding soil processes, therefore, this results will have implications for agricultural practices, environmental management, and land use planning, and will contribute to the understanding of soil dynamics and sustainability.

5.1 Results of Saturated Hydraulic Conductivity on the Falling Head Permeameter

In general terms, the results of the K measurements for the three localities presented in Tab. 3 suggest that the addition of compost on the soil surface as mulch can improve the saturated hydraulic conductivity (K).

Table 3. Average saturated hydraulic conductivity values at studied localities

	Average K value [m/d]			
	Locality U: Praha –Uhříněves (16th August)	**Locality B: Jevíčko (8th June)**	**Locality B: Jevíčko (4th August)**	**Locality C: Velké Hostěrádky (9th June)**
Treated Parcel	12.70	9.97	8.96	7.06
Control Parcel	9.64	5.83	5.10	5.86

Source: Author, 2023

The average K values for the treated and control parcels in Locality U (Praha-Uhříněves) indicates that the addition of compost has an impact on the saturated hydraulic conductivity of the soil. However, it should be declared, that the amount of samples was not representative and the parcels were already harvested, thus the porous system could be affected. Although the sampling was carried out with special with respect to the porous system, the data ranged from 0.13 m/d to 65.84 m/d.

In Locality B (Jevíčko), both the treated and control parcels had lower K values than Locality U. However, the average saturated hydraulic conductivity values for Jevíčko on 8th June and 4th August reveals some interesting patterns. On 8th June, the results show a different trend, with the treated parcel having a higher average K value of 9.97 m/d compared to the control parcel with a value of 5.83 m/d. On the other hand, On 4th August, the control parcel has a lower average K value of 5.10 m/d compared to the treated parcel with a value of 8.96 m/d.

Between the two sampling dates, a decrease in the data can be observed, suggesting that the natural seasonal consolidation process of the soil took place.

In contrast, Locality C (Velké Hostěrádky), the treated parcel had almost the same K value as Locality B in the same sampling period (June); however, the treated parcel showed lower increase in K than Locality B, only 20% compared to Jevíčko, where the increase on treated parcel was 71%, respectively 76%.

On the following figures are plots of statistical analysis conducted by STATGRAPHICS Centurion XIX. The test used was multifactorial ANOVA with main effects.

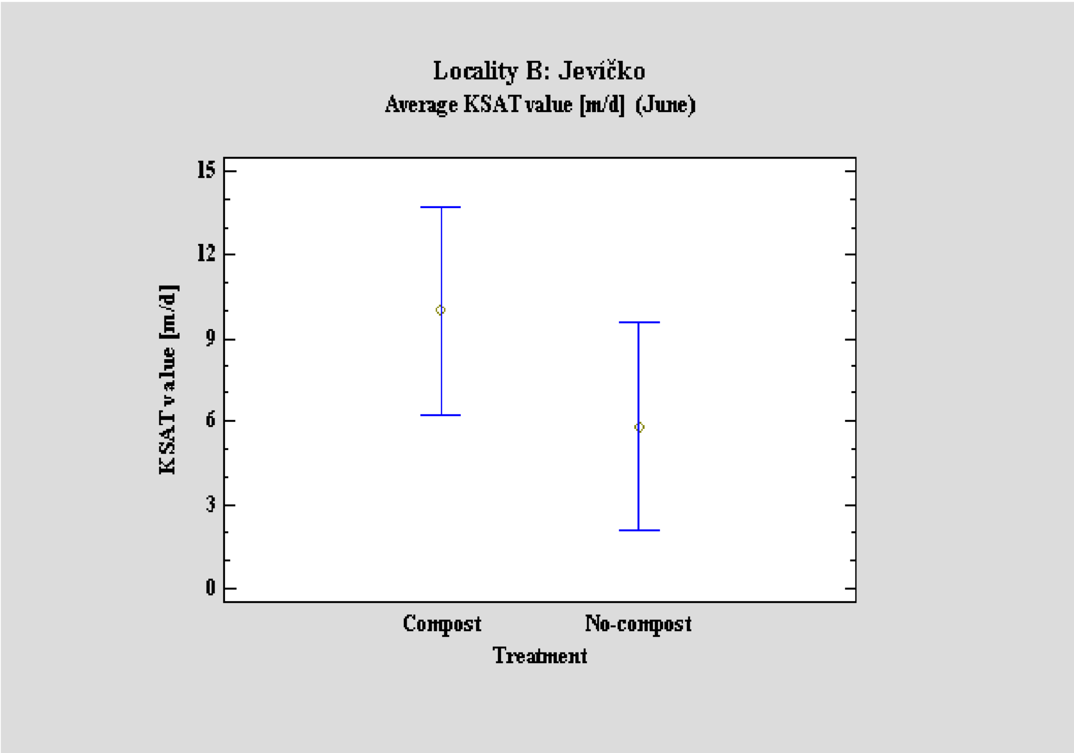

Figure 12. K value Locality B (June): Jevíčko. Source: Author, 2023

Fig. 12 shows K values for Locality B Jevíčko on 8th June. The K values vary greatly among the different samples and treatments. The control parcel shows lower K values ranging from 0.009 to 15.4 m/d, while the treated parcel shows higher K values ranging from 0.4 to 41.8 m/d. This indicates that the application of compost may have a positive impact on the hydraulic conductivity of the soil, potentially improving its ability to conduct water.

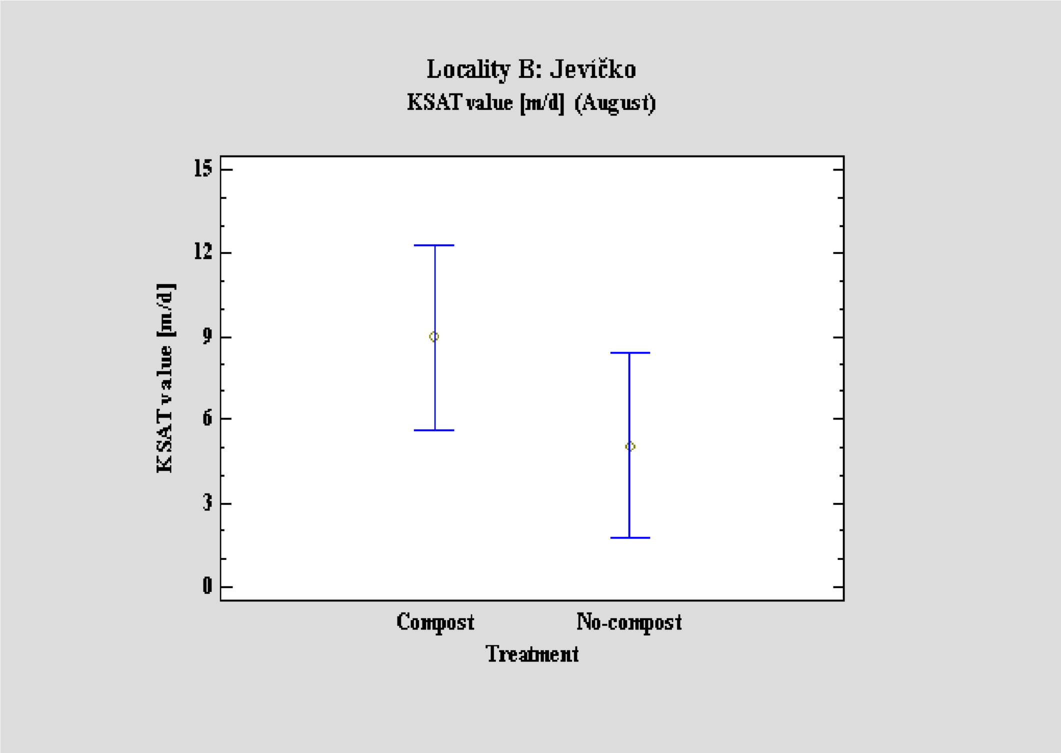

Figure 13. Saturated hydraulic conductivity values for Locality B (August): Jevíčko. Source: Author, 2023

Fig. 13 shows K values for Locality B Jevíčko sampling date 4th August, here the treated and control parcels show a slightly higher difference in soil hydraulic conductivity than in June. Data shows the treated parcel with compost had higher K values compared to the control parcel. The highest K value observed in the treated parcel was 37.58 m/d, which is significantly higher than the highest value observed in the control parcel 13.56 m/d.

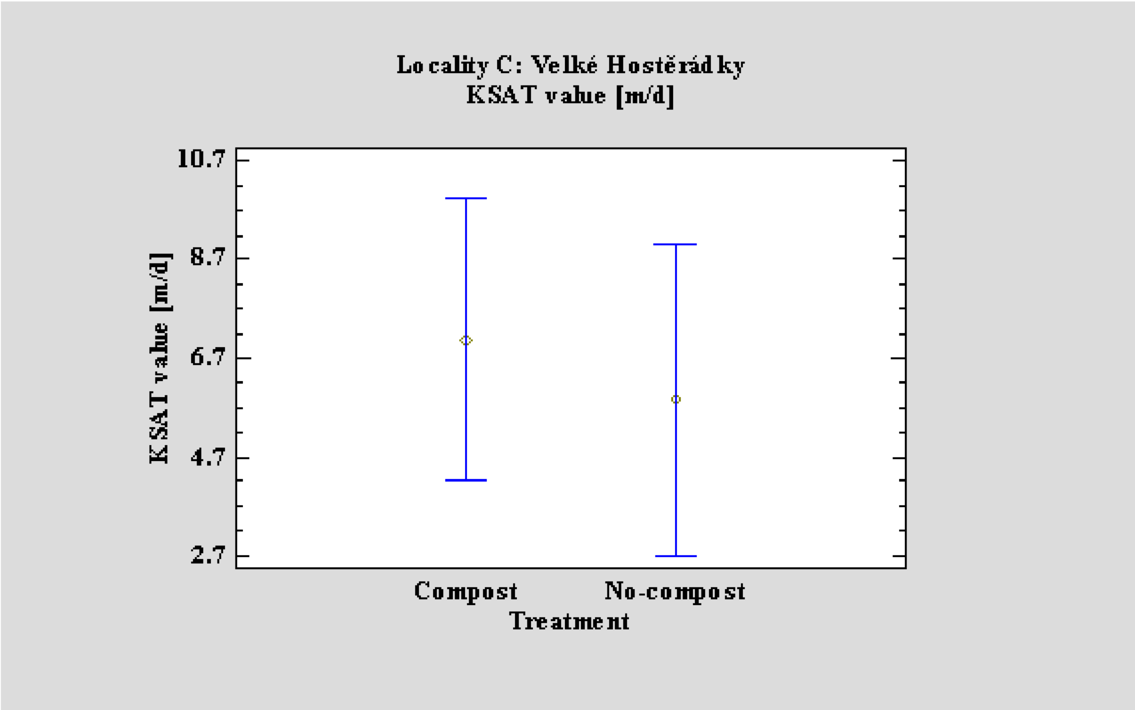

Figure 14. Saturated hydraulic conductivity values for Locality C: Velké Hostěrádky. Source: Author, 2023.

The K values for Locality C (Velké Hostěrádky) on Fig. 14, show a non-significant difference between soil treated with compost and without compost. The average of measurements shows the treatment with compost had higher K values than the control group without compost, this suggests that the addition of compost on the soil surface has a positive impact on saturated hydraulic conductivity. The highest K value observed in the treated parcel with compost was 30.24 m/d, while the lowest value was 0.06 m/d. The control parcel without compost had a wide range of K values, with the highest value observed at 13.39 m/d and the lowest value at 0.4 m/d.

5.2 Soil Water Content

The actual water content of soil is an important parameter which is affected by the physical, chemical, and biological properties of soil. The Tab. 4 shows the values obtained of actual water content (% by volume), for the three localities under the study. In general, the treated parcels in all three localities had higher average actual water content compared to their respective control parcels, which suggests that the addition of compost improved the water retention capacity of the soil in these areas.

Table 4. Actual Water Content Localities

	Average Actual Water Content (% by volume)			
	Locality U: Praha -Uhříněves	**Locality B: Jevíčko**		**Locality C: Velké Hostěrádky**
		(8th June)	**(4th August)**	
Treated Parcel	16.03	40.66	24.06	27.44
Control Parcel	14.83	34.63	22.15	23.08

Source: Author, 2023

In the Locality U: Praha -Uhříněves, the actual water content of the treated parcel with compost was 16.03%, while the control parcel had an actual water content of 14.83% showing an increase 1.2% by volume.

Based on the available data, the analysis of the average actual water content (% by volume) in Locality B (Jevíčko) reveals interesting findings. On 8th June, the treated parcel with compost had a higher actual water content of 40.66% compared to the control parcel with 34.63%. However, on 4th August, the soil was much drier and the difference between treatments was almost insignificant with actual water content of 24.06% on compost parcel compared to the control parcel at 22.15%. These observations indicate that the actual water content in Locality B (Jevíčko) is subject to temporal variability.

Finally, the data from Locality C: Velké Hostěrádky shows the treated parcel had an actual water content of 27.44%, while the control parcel has an actual water content of 23.08%. Overall, the water content is higher in Localities B and C compared to Locality U, both with and without the use of compost therefore, the addition of compost generally increases the water content in all three localities, although the degree of increase varies, for example, the largest increase is seen in the treated and control parcels of Locality C (27.44% with compost vs. 23.08% without, which the highest relative difference of 19%), followed by the treated and control parcels of Locality B with the temporary variability of the data, and finally Locality U (16.03% with compost vs. 14.83% without, which is 8% relative difference). It is possible to determine that, comparing the three localities, locality B had the highest water content with and without compost in June, while locality U had the lowest in August.

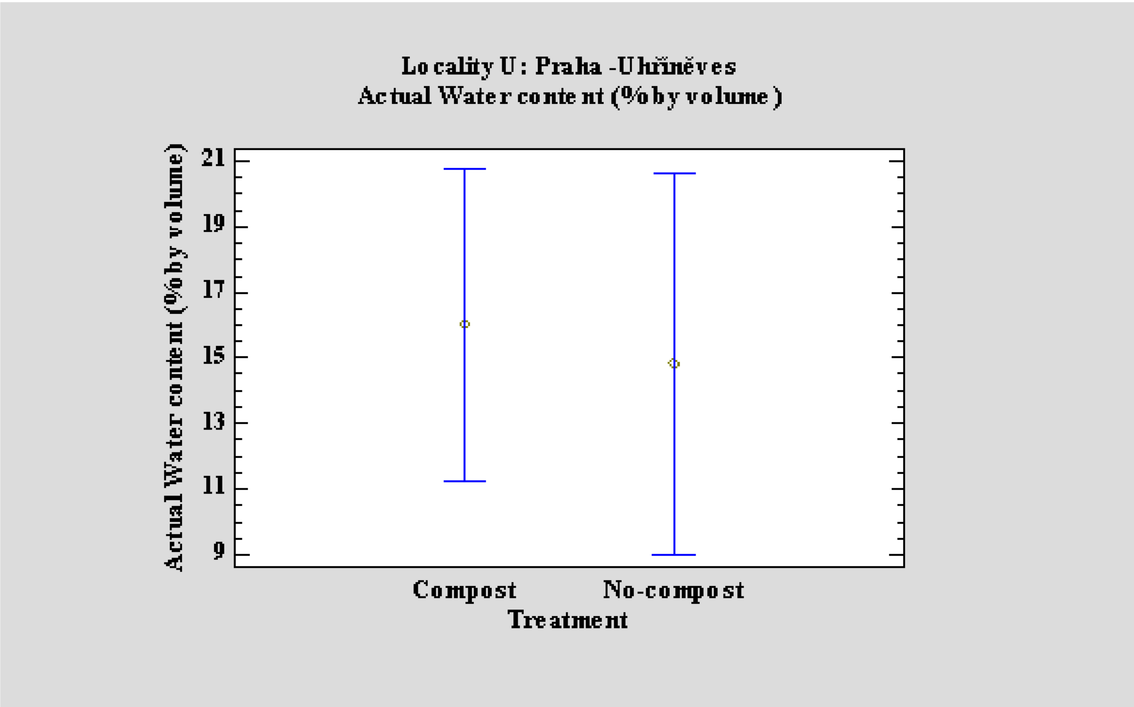

Figure 15. Actual Water Content for Locality U: Praha -Uhříněves. Source: Author, 2023

Fig. 15 shows the actual water content (% by volume) of Locality U: Praha -Uhříněves, the data suggests that the treated parcel with compost has a higher water content compared to the parcel without compost. The average of the measurements shows a difference of 1.20% by vol.

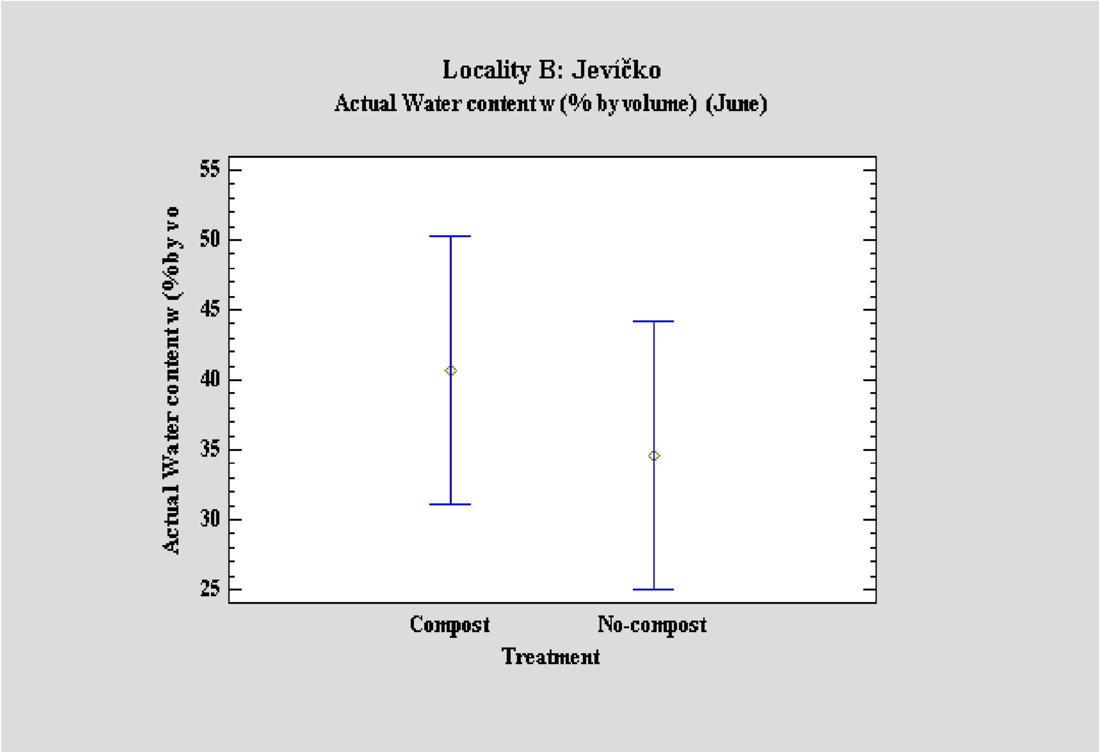

Figure 16. Actual Water Content in June at Locality B: Jevíčko. Source: Author, 2023

Fig. 16 shows the actual water content (% by volume) obtained from the data on June for Locality B: Jevíčko. Overall, samples treated with compost tend to have a higher actual water content compared to samples of the control parcel, also, these findings suggest that the application of compost may influence the actual water content in the samples, with higher values observed in some cases.

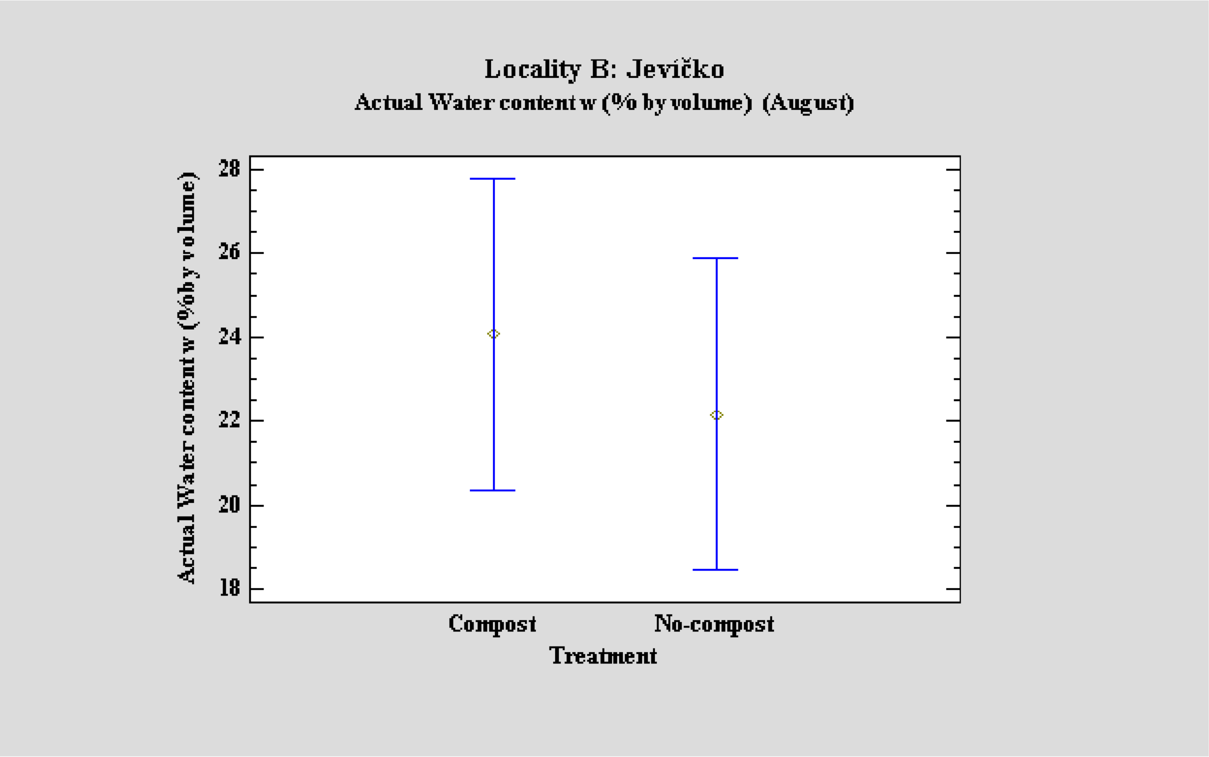

Figure 17. Actual Water Content in August at Locality B: Jevíčko. Source: Author, 2023

Fig. 17 shows the actual water content (% by volume) obtained from the data on August for Locality B: Jevíčko.

It is possible to determine that, the general average shows an small-scale variation between the plot treated with compost and the untreated plot, therefore the data suggests that the use of compost increased slightly the water content in the parcel with compost due to has a slightly higher average (24.06%) compared to the parcel without compost (22.15%).

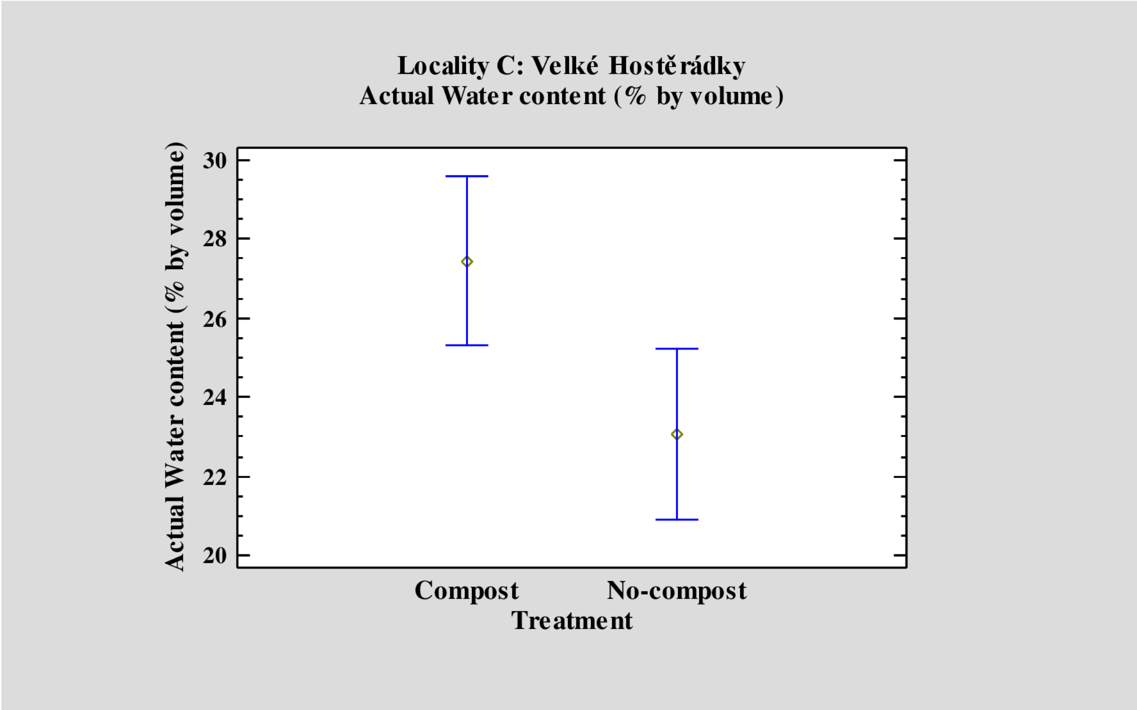

Figure 18. Actual Water Content for Locality C: Velké Hostěrádky. Source: Author, 2023

According to the data obtained after the determination of actual water content (% by volume) for Locality C: Velké Hostěrádky, on Fig. 18, it is possible to observe that the use of compost can increase water content in soil, due to the parcel with compost had a consistently higher water content compared to the parcel without compost. Overall, the data shows that the parcel with compost had a higher average water content (27.44%) compared to the parcel without compost (23.08%), and the difference is significant on $p < 0.05$.

5.3 Aggregate Stability

The Water Stability Index (WSA) is a quantitative measure used to assess soil structure stability, with values reported as unitless numbers ranging from 0 to 1. Higher values on the WSA index indicate better stability of soil structure. The data presented in Tab. 5 shows the WSA index (Water Stable Aggregates) values for treated and control parcels in Locality U: Praha -Uhříněves and control parcel Locality B Jevíčko. In Locality U Praha -Uhříněves, the treated parcel had a WSA index average of 0.89, while the control parcel had a WSA index average of 0.79. On the other hand, in Locality B Jevíčko, the control parcel had a lower WSA index average of 0.76.

Table 5. Water Stable Aggregate Index

	Average WSA Index (-)	
	Locality U: Praha -Uhříněves	**Locality B: Jevíčko**
Treated Parcel	0.89	---
Control Parcel	0.79	0.76

Source: Author, 2023

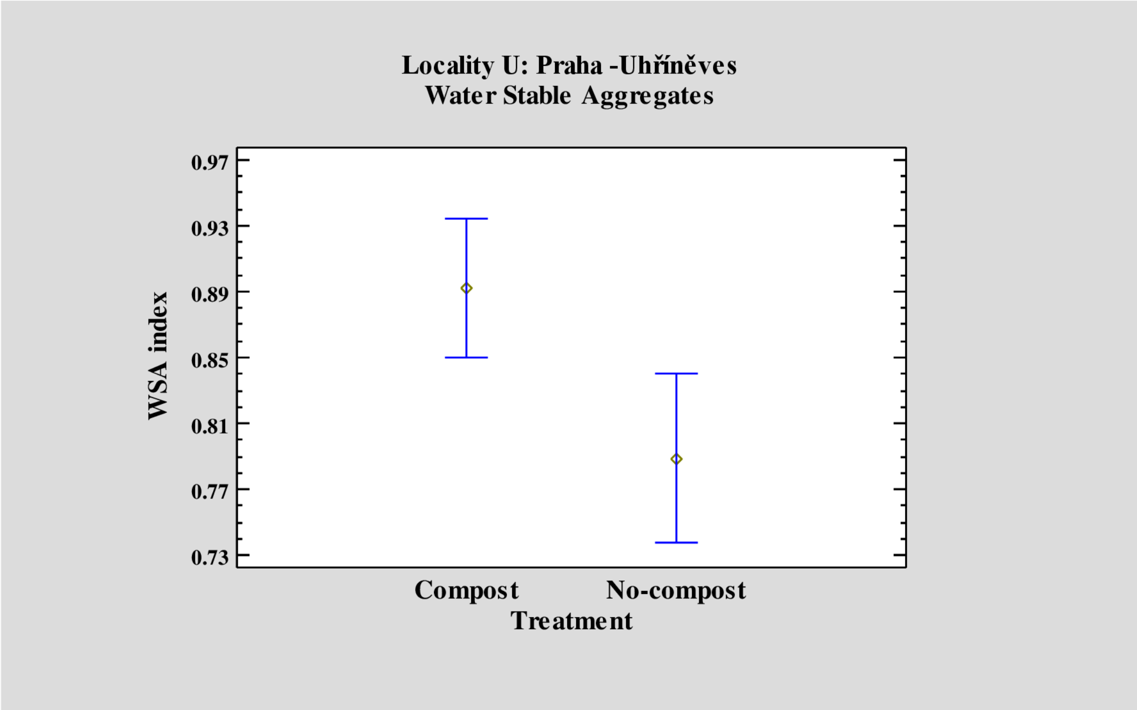

Figure 19. Water Stable Aggregates Index for Locality U: Praha -Uhříněves.
Source: Author, 2023

In Fig. 19, it is possible to observe that the data of parcel treated with compost had values ranging from 0.66 to 0.97, while the parcel without compost treatment had values ranging from 0.57 to 0.91. It indicates that the WSA index values for the plot with compost treatment was generally higher compared to the plot without compost treatment, and the difference is significant on $p < 0.05$.

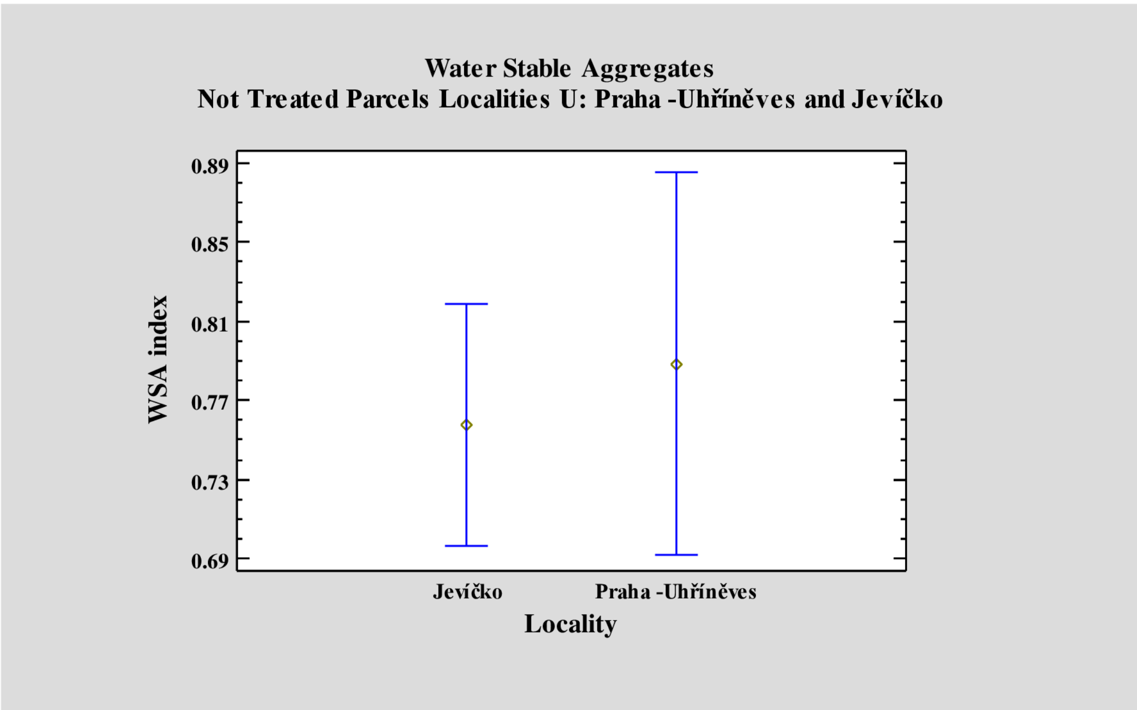

Figure 20. Water Stable Aggregates Index for Not treated Parcels.
Locality U: Praha -Uhříněves and Locality B: Jevíčko. Source: Author, 2023

In Fig. 20, it is possible to infer that the values of the WSA index in not treated plots in Locality U: Praha-Uhříněves are consistently higher than those for Locality B: Jevíčko. The WSA values for the plot without compost treatment at Locality U: Praha - Uhříněves ranged from 0.87 to 0.57, meanwhile, at the same plot without compost treatment at Locality B: Jevíčko, the WSA values varied from 0.43 to 0.99.

5.4 Particle Size Distribution

Tab. 6 provide insights into the particle size distribution characteristics of the soil samples from different localities and their respective soil types. The data represents the results of Particle Size Distribution (PSD) analysis for different samples (labeled B1, B2, B3, B4, C5, C6, C7, C8, U) from the study localities, with the soil type identified as Silty Clay Loam, except of one sample in B locality and sample from U locality. The PSD is expressed as percentages of clay, silt, and sand in the soil.

Table 6. Particle Size Distribution

Particle Size Distribution						
No	**Sample**	**Locality**	**PSD**			
			% of clay	**% of silt**	**% of sand**	**Soil Type :**
1	B1	Locality B: Jevíčko	30	66	4	Silty Clay Loam
2	B2		25	70	5	Silt Loam
3	B3		35.5	60	4.5	Silty Clay Loam
4	B4		32	60	8	Silty Clay Loam
5	C5	Locality C: Velké Hostěrádky	31	60	9	Silty Clay Loam
6	C6		30	55.5	14.5	Silty Clay Loam
7	C7		32	56	12	Silty Clay Loam
8	C8		37.5	56	6.5	Silty Clay Loam
9	U	Locality U: Praha -Uhříněves	17.5	57	25.5	Silt loam

Source: Author, 2023

Samples B1, B3, and B4 from Locality B: Jevíčko have similar PSD characteristics with 30-35.5% clay, 60-66% silt, and 4-8% sand in the soil. Sample B2 from Locality B: Jevíčko has slightly lower clay content (25%) compared to other samples, higher silt content (70%), and similar sand content (5%) indicating a slightly different PSD compared to the other samples.

On the other hand., samples C5, C6, C7, and C8 from Locality C: Velké Hostěrádky have similar PSD characteristics with 30-37.5% clay, 55.5-60% silt, and 6.5-14.5% sand in the soil. Overall, all samples have a similar soil type of Silty Clay Loam with varying percentages of clay, silt, and sand.

5.5 Soil Organic Carbon determined by Modified Walkley-Black Protocol

From the data obtained regarding Soil organic Matter content (Tab. 7), it is possible to establish that for Locality B: Jevíčko, the percentage of soil organic matter increased in the treated parcel for 0.96% in comparison with the control parcel, and the difference is significant on $p < 0.005$. On the other hand, for Locality C: Velké Hostěrádky, the treatment did not show an effect on increasing the SOM% in the treated parcel compared to the control parcel, however, it is necessary to mention that the data was taken only in the first sample period, for that reason the data is not sufficient to establish a comparison during the time.

Table 7. Soil Organic Matter Content

	Averages SOM (%)	
	Locality B: Jevíčko	**Locality C: Velké Hostěrádky**
Treated Parcel	3.12	2.35
Control Parcel	2.16	2.51

Source: Author, 2023

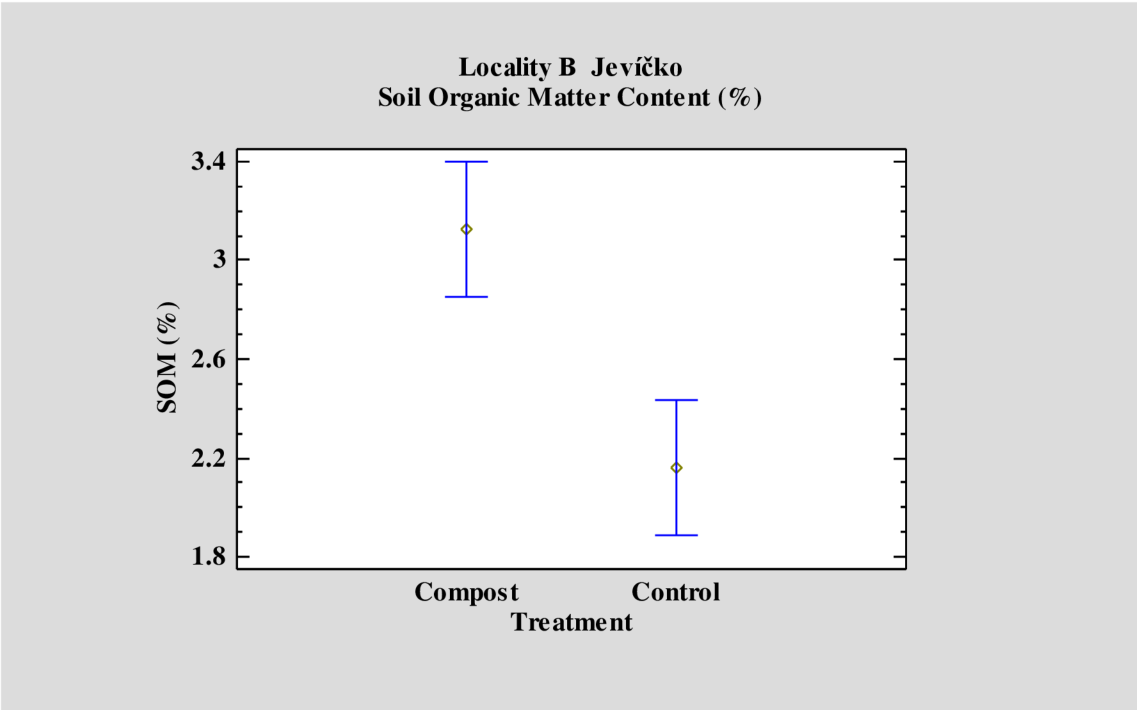

Figure 21. Soil Organic Matter Content Locality B: Jevíčko.
Source: Author, 2023

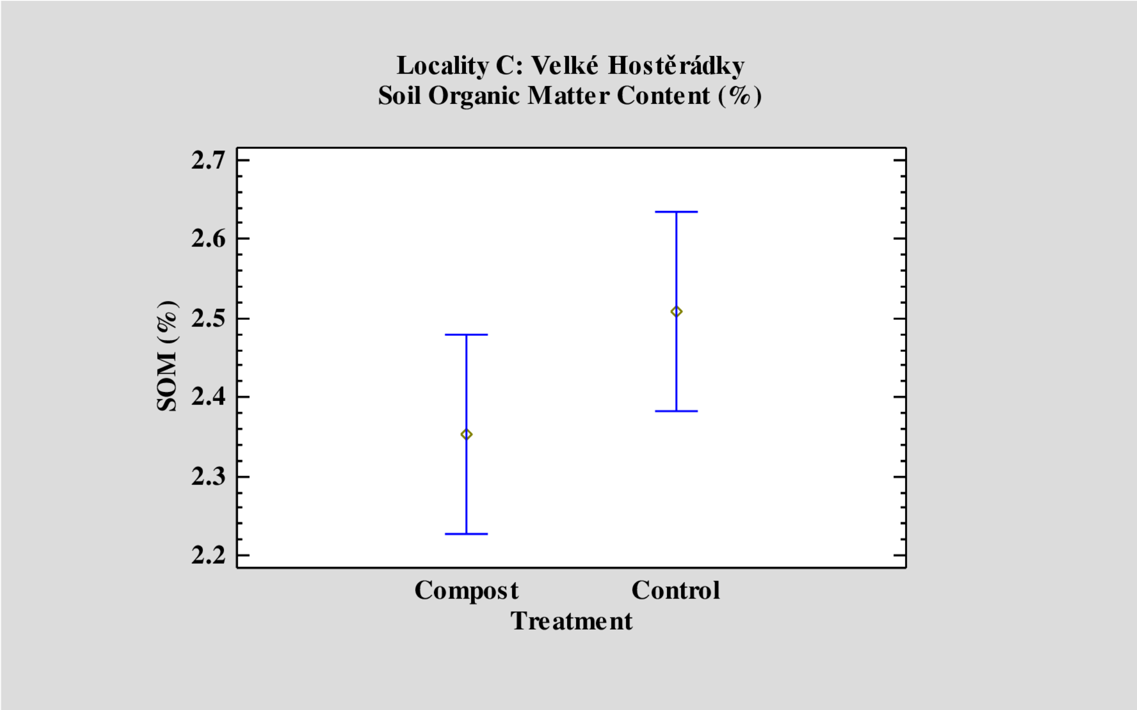

Figure 22. Soil Organic Matter, Locality C: Velké Hostěrádky.
Source: Author, 2023

In Fig. 21 and 22, it is possible to observe that the mean value for treated parcel is higher that control parcel in Locality B: Jevíčko, and the mean value for control parcel it is higher that treated parcel in Locality C: Velké Hostěrádky. The figures also show an increment in SOM% in Locality B: Jevíčko, in contrast, for Locality C: Velké Hostěrádky in which the percentage of SOM decreased.

On the other hand, data shows that the SOM% for Locality B: Jevíčko is 3.12% for the treated parcel and 2.16% for the control parcel and the SOM% for Locality C: Velké Hostěrádky is 2.35% for the treated parcel and 2.51% for the control parcel, therefore, is possible to determine that Locality B: Jevíčko had a higher overall SOM% compared to Locality C: Velké Hostěrádky.

6 Discussion

Surface application of compost has the potential to improve soil physical properties such as saturated hydraulic conductivity, soil water content, aggregate stability, and soil organic matter, which are essential for maintaining healthy and productive soils. Regarding saturated hydraulic conductivity K and soil water content, the present study shows significant differences in those parameters between the two plots, one with compost and the other without compost, which can be attributed to several factors.

The results obtained in the present study demonstrate a consistent trend across all three localities, wherein the parcels treated with compost exhibited a notable increase in hydraulic conductivity (K) values and actual water content (%) compared to the control plots. These findings align with previous research conducted by several reputable studies, including but not limited to i) Bero & Bero (2022) who demonstrated that during the 3.5-year study period, the application of compost at a rate of 1.3 cm depth per year, resulted in the maintenance of acceptable turf quality and significant improvements in various essential physical properties of the soil including K values, ii) Yüksel & Kavdır (2020) reported that the addition of compost decrease bulk density and increased hydraulic conductivity positively influenced physical and chemical characteristics of clay-loam soils of arid and semi-arid climates.

Based on the findings of this study, which showed improved K values and actual water content, it can be inferred that the surface application of compost has the potential to enhance soil structure in the localities. This observation is supported by the research conducted by Kranz et al. (2023), who reported increased aggregation of soil particles, resulting in improved soil structure and higher K values due to increased pore space and enhanced water infiltration. However, it should be noted that the authors of this study emphasize the importance of considering soil texture and structure, as these factors can directly influence the distribution of water in different pore fractions, such as gravitational, plant-available, and unavailable water.

Another possible explanation of the improvement of K values and actual water content is, the compost also increased the organic matter content, which improved soil moisture retention (Castellini et al. 2022), therefore, from the results it is possible to determine that the increased organic matter content resulting from the application of compost to the treated parcels may have contributed to the observed difference in soil moisture content (data obtained from Locality B: Jevíčko).

Additionally, it is important to consider the sampling process and the seasonality aspect. Data from this study suggest a notable difference in the average K values and actual water content in Locality: Jevíčko between the two sampling dates, one in June and the other in August. These differences may be attributed to temporary variations associated with the beginning and conclusion of summer, including fluctuations in precipitation rates and higher temperatures leading to increased water evapotranspiration and soil drying. This fact is supported by Farkas et al. (2006) who found seasonal variability of the soil hydraulic functions, due to the values of saturated hydraulic conductivity obtained in the ploughing treatment at the beginning and at the end of the vegetation period differed up to 4 times. Also, Bourletsikas et al. (2023) demonstrated that the primary cause of soil moisture fluctuations up to a shallow soil depth of 40 cm is precipitation because water infiltrates more quickly into the upper soil layer (0–40 cm), which also exhibited substantial soil moisture variability, particularly in monthly and seasonal (year–to–year) time steps.

Therefore, it is crucial to consider the sampling process and seasons conditions when interpreting the results. It is evident that seasonal conditions, such as precipitation rate in dry periods, have a direct effect on these parameters rather than the surface application treatment. Thus, accounting for temporary variations is essential in accurately determining the factors influencing the decrease in Ksat values and water content between the two sampling dates in Locality B: Jevíčko.

Concerning Locality C: Velké Hostěrádky, was evidenced an increase in the values obtained from KSAT and water content, however, data obtained from SOM showed a decrease, which could be due to several reasons such as: i) Incorrect application: If the compost is not applied correctly, it could potentially lead to a decrease in soil organic matter. For example, if too much compost is added, it could create conditions that are unfavorable for soil microorganisms that help to break down organic matter, resulting in less SOM (Masmoudi et al. 2020). This could be expected in Bm locality, where an extreme dose of compost was applied, but results did not show this effect. ii) Differences in initial SOM levels and different practices such as tillage can affect the stability of the smallest aggregates in soil, and this can have implications for the conservation of soil organic matter (Jakab et al. 2016).

In contrast, in Locality B: Jevíčko, the treated parcel showed an increase in the percentage of soil organic matter compared to the control parcel after the surface application of compost. This finding is consistent with the research conducted by Rivero et al. (2004) which demonstrated that compost application can increase soil organic matter (SOM) in quality and quantity. Also, the study conducted by Bekier et al. (2022) suggests that mature composts is more effective in improving SOM levels compared to fresh and immature composts, as mature composts contain higher levels of stable carbon that contribute to greater accumulation of SOM in the soil. Other studies, such as Rivero et al. (2004) have also reported similar findings, showing that compost application can positively impact on soil organic matter content and that the maturity of compost can affect its effectiveness in improving SOM levels. These findings support the notion that compost application, particularly with mature composts, can be an effective strategy for enhancing soil organic matter content and promoting soil health.

Regarding aggregate stability, in the present study, the Water Stability Index (WSA) values were used to assess soil aggregate stability and were reported as unitless values ranging from 0 to 1, therefore, higher values of WSA indicate better soil aggregate stability. The data from Locality U: Praha - Uhříněves showed that the use of compost in treated parcels resulted in higher WSA index values, indicating improved soil aggregate stability. These findings are consistent with the research conducted by Celik (2004), which also demonstrated that the use of compost as an amendment can enhance soil aggregate stability and water holding capacity. Celik's study highlighted that the application of mycorrhizal inoculation and compost can lead to increased microbial activity and improved soil structure, resulting in better soil aggregate stability. This can be attributed to the organic matter and nutrients present in compost, which provide a favorable environment for microorganisms to thrive and facilitate the formation of stable aggregates. The findings of Celik's study, along with the results of the present study, suggest that the use of compost can positively impact soil structure stability by promoting aggregate formation and improving the overall health and functionality of the soil.

Furthermore, similar results have been reported in other studies as well. Juriga & Šimanský (2018) found that the addition of biochar and combination biochar-compost to soil resulted in increased soil aggregate stability, however, the authors noted that the effects of application of biochar and the application of the combination biochar-compost to soil aggregate stability can vary depending on factors such as the inherent complexity of biochar, soil properties, and cropping system. Additionally, Whalen et al. (2003), demonstrated that the use of compost improved stability and aggregation in soil by enhancing soil organic matter content and microbial activity, in both conventional and no-tillage systems. These studies further support the findings of the present study and emphasize the beneficial effects of compost on soil structure stability.

The analysis of WSA in Locality B: Jevíčko, which did not involve any compost treatment, highlights the importance of considering the topography of the land in the data interpretation. The results clearly demonstrate that the aggregate stability of the soil varies significantly depending on the elevation, with the highest points exhibiting less stability compared to the lowest points on the slope. One possible explanation for the observed variation in soil stability with elevation could be attributed to water movement dynamics on the terrain, as water tends to runoff more easily from the surface of the soil at the top of the slope compared to flat ground. This affirmation is supported by Zádorová et al. (2011) who supported the hypothesis that water runoff and its associated effects, such as erosion and loss of soil structure, may contribute to the lower water-stable aggregates (WSA) index observed at higher elevations. Also, Shinjo et al. (2012) supported this hypothesis and revealed that the slope factor plays a crucial role in influencing the mobility of aggregates, with steeper slopes showing a positive correlation with increased aggregate mobility.

On the other hand, the data observed in particle size distribution revealed that the samples analyzed exhibited a general trend of being classified as Silty Clay Loam soils. As is demonstrated in this study, the application of compost can potentially have several positive effects on soils with such characteristics, as it is indicated in the specific analysis of each physical property under investigation.

Overall, the statistical data analysis supports the conclusions drawn from the data analysis and discussion. The compost without incorporation applied to the soil in the treated parcels had a significant positive effect on soil physical properties, resulting in an increase in all the analyzed parameters in all three localities (saturated hydraulic conductivity Ksat, water content, aggregate stability, and soil organic matter content) with some differences. The statistical significance of the results varies between localities, but the trend of improvement in the different values in the treated parcels is consistent across all localities.

7 Conclusion

- After the data analysis of this thesis project, it is possible to determine that the application of compost to the soil surface without incorporation had a positive influence on several soil properties, including soil water content, saturated hydraulic conductivity, soil organic matter content, and aggregate stability. Regarding soil water content, the addition of compost to the soil surface can increase this parameter by improving soil structure and porosity which could lead to better plant growth, reduced water stress, and increased soil productivity. The data of K measurements showed that the application of compost without incorporation also improved the soil hydraulic conductivity in treated parcel; this could help water infiltrate into the soil more quickly, reducing runoff and erosion, and improving soil fertility. Regarding water content, it is important to note that the optimal amount of compost needed to achieve maximum water retention can vary depending on soil type, climate, and other factors. Additionally, the quality of the compost used can also affect the degree of water retention according to some authors. Overall, data on this study suggests that the use of compost may increase water content in soil, which can have beneficial effects on plant growth and soil health.

- Enhanced aggregate stability, is well known that the addition of compost to the soil surface can improve soil aggregate stability by promoting more stable particle binding that resist erosion and improve soil structure, therefore this study gave results in accordance with the literature showing that the use of compost in treated parcels had higher values in Water Stable Aggregates index (WSA index), than the control parcels in each localities.

- The use of compost in the treated parcels showed higher values of soil organic matter percentage than the control parcels, however those results correspond only for Locality B Jevíčko, where the sampling processes was carried out twice at different times, for Locality C: Velké Hostěrádky the sampling process was carried out just in one period which allows to conclude that it is absolutely necessary to perform the sampling process at different times to verify an increment in soil organic matter percentage. This is necessary because compost addition to soil can have immediate and long-term effects on soil properties, where the long-term effect is usually more accurate due to the gradual decomposition of the organic matter of compost, which releases nutrients into the soil and can further increase soil organic matter percentage on it.

- It can be concluded, that the scientific hypothesis was confirmed and the objectives of the thesis were fulfilled.

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