EFFECT OF EMPTY FRUIT BUNCH COMPOST AND SOIL TEXTURE ON ROOT CHARACTERISTICS AND YIELD OF PURSLANE (*Portulaca oleraceae* L.)

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ABSTRACT

This study was carried out to evaluate the effect of an Empty Fruit Bunch (EFB) compost and soil texture on root characteristics and yield of purslane, (*Portulaca oleracea* L.). The objective of this experiments was to evaluate the effect of EFB compost on yield and roots characteristics of purslane on different soil media and to evaluate the effect of EFB compost on selected soil properties. This experiment was using completely randomized design (CRD) and it took approximately 10 weeks of planting duration that begin from soil pot preparation till harvesting. The treatments of this studies are the different rate of application of EFB compost on the different type of soil media; 0 t ha^{-1}, 5 t ha^{-1}, 10 t ha^{-1} and 15 t ha^{-1}. The control of this experiment was the 0 t ha^{-1} of EFB compost application. Each treatments were replicated 4 times. Plant green biomass (leaf+stem) fresh and dry matter yield, root diameter, root surface area, root dry weight, root length, root and shoot ratio were measured after harvest. Meanwhile, soil pH, soil organic matter, total organic carbon, soil total nitrogen and soil available phosphorus were measured during before and after planting. Except for fresh and dry weight, all the parameters of roots were measured using WinRhizo 2016a. All data were then analysed using two way ANOVA at 5% level of significance and Tukey's test to analyse the mean separation. The results show that, the plants that were planted on clay soil with treatments level 15 t ha^{-1} shows the highest mean of plant total above ground fresh and dry matter weight, 13.51 and 124.16g, respectively. As for root parameters, there were significant interaction between soil type and treatment levels on roots surface area and root length results. With clay soil and treatment 5 t ha^{-1}, it gives the highest results for root surface area (922.31mm) and for root length, clay soil with treatment 15 t ha^{-1} gives the highest results (9869.86mm). However, there were no significant difference on the results of plant total dry matter, diameter of plant roots and root to shoot ratio. With the highest results of 1.58g at treatment 15 t ha^{-1}, 0.79g and 0.22g at treatment 0 t ha^{-1}, respectively. For soil parameters, soil total carbon shows significant interaction on clay soil and treatment 15 t ha^{-1} with the highest result of 0.91%. However, for soil total nitrogen, soil available phosphorus and soil pH showed no significant difference. With highest results, 2.08% at treatment 10 t ha^{-1}, 0.76% at treatment 15 t ha^{-1} and 5.82 pH at treatment 0 t ha^{-1}. The overall results of this experiments prone to show that the plants tends to strive better when applied with more amount of compost regardless of the type of soil. Most of the roots characteristics also shows a good respond toward the increasing rate of EFB application. Hence, EFB compost is recommended to be used to fix problematic soil.

KESAN KOMPOS EFB DAN TEKSTUR TANAH KEPADA CIRI-CIRI AKAR DAN HASIL PURSLANE (Portulaca oleaceae **L.)**

ABSTRAK

Kajian ini akan dijalankan untuk menilai kesan Kompos buah tandan kosong (EFB) dan tekstur tanah terhadap hasil dan ciri akar purslane, *Portulaca oleracea* L. Objektif bagi ujikaji ini adalah untuk menilai kesan EFB kompos kepada ciri-ciri hasil dan akar purslane di media tanah yang berbeza dan untuk menilai kesan EFB kompos pada sifat tanah yang terpilih. Eksperimen ini telah menggunakan reka bentuk rawak lengkap (CRD) dan ia mengambil masa kira-kira 10 minggu tempoh penanaman yang bermula dari persiapan pasu penanaman sehingga penuaian. Rawatan kajian ini adalah kadar penggunaan EFB kompos yang berbeza pada media tanah; 0 t ha-1, 5 t ha-1, 10 t ha-1 dengan 15 t ha-1. Kawalan rawatan bagi kajian ini ialah 0 t ha^{-1}. Setiap rawatan akan direplikasi sebanyak 4 kali. Berat biomas hijau (daun + batang) segar dan kering, diameter akar, kawasan permukaan akar, berat kering akar, panjang akar, nisbah akar dan biomas hijau akan diukur selepas tanaman dituai. Sementara itu, pH tanah, bahan organik tanah, jumlah karbon tanah, jumlah nitrogen tanah dan jumlah fosforus dalam tanah diukur semasa sebelum dan selepas menanam. Kecuali berat basah dan kering, semua parameter akar diukur menggunakan WinRhizo 2016a. . Semua data akan dianalisis menggunakan dua cara ANOVA pada tahap 5% daripada kepentingan dan juga menggunakan ujian Tukey's test untukmenganalisis purata pemisahan data. Keputusan bagi kajian ini menunjukkan bahawa tumbuhan yang ditanam di atas tanah liat dengan rawatan 15 t ha^{-1} menunjukkan purata keputusan yang tertinggi, pada berat segar dan kering iaitu 13.51g dan 124.16g. Bagi parameter akar, interaksi yang ketara dapt dilihat antara jenis tanah dan tahap rawatan pada parameter kawasan permukaan akar dan juga panjang akar. Dengan tanah tanah liat dan rawatan 5 t ha^{-1}, ia memberi keputusan tertinggi bagi kawasan permukaan akar (922.31mm) dan untuk panjang akar, interaksi antara tanah liat dan rawatan dengan 15 t ha^{-1} memberi keputusan tertinggi (9869.86mm). Walau bagaimanapun, tidak ada perbezaan yang ketara terhadap keputusan berat kering akar, diameter akar tumbuhan dan juga terhadap nisbah akar dan biomass hijau. Dengan keputusan tertinggi rawatan 1.58g pada 15 t ha^{-1}, 0.79g dan rawatan 0.22g pada 0 t ha^{-1}. Bagi parameter tanah, jumlah total karbon dalam tanah menunjukkan interak ke atas tanah liat dan rawatan 15 t ha-1 dengan keputusan yang paling tinggi iaitu 0.91%. Walau bagaimanapun, bagi jumlah nitrogen tanah, jumlah fosforus tanah dan pH tanah tidak menunjukkan perbezaan yang signifikan. Dengan keputusan tertinggi iaitu, 2.08% pada rawatan 10 t ha^{-1}, 0.76% pada rawatan 15 t ha^{-1} dan 5.82 pH pada rawatan 0 t ha-1. Keputusan keseluruhan eksperimen ini menunjukkan bahawa pokok purslane cenderung untuk bertumbuh lebih baik apabila dirawat dengan jumlah kompos yang lebih tanpa mengira jenis tanah. Kebanyakan ciri-ciri akar Juga menunjukkan respon yang baik terhadap peningkatan EFB kompos. Oleh itu, EFB kompos adalah disyorkan untuk digunakan bagi merawat tanah bermasalah.

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ANOVA	Analysis of variance
CRD	Completely randomized design
EFB	Empty fruit bunch
OM	Organic matter
TNC	Total Nitrogen Content
TCC	Total Carbon Content

CHAPTER 1

INTRODUCTION

1.1 Introduction

Although some parts of the world claim it as invasive weeds, purslane can actually be of use to humans. Purslane or *Portulaca oleracea*, belongs to the family of Portulacaceae. P. oleracea is a herbaceous, succulent annual that grows to heights of 10 to 30 cm and prefer sandy soil and warmer conditions. It has a reddish-brown stem and alternate wedge-shaped leaves, cluster of yellow flowers containing 4 to 6 petals and numerous black, shiny, and rough seeds. This plant has always been classified as one of the ten most noxious weeds in the world because of its invasive rapid growth. However, it is still eaten as a leafy vegetable by a lot of people. Reportedly, this plants has more omega-3 fatty acids and antioxidants than any other foods (Simopoulus., 2004). This plant is suitable to be planted on light (sandy) and medium (loam) soils and it prefers well-drained soil. However, Purslane is a tough herbaceous plant and its roots can penetrate even clay soils. The flowers of purslane are hermaphrodite (have both male and female organs)and are pollinated by insects. The plant is self-fertile. This plant promises an excellent future for human consumption either for daily consumption like '*ulam*' or salad, or by converting it into medicines, as it has high nutritive value especially omega-3 fatty acid content (Uddin *et al.,* 2012).

The roots system is a very important part of a plant. Just as how the above ground part of plants is important, the same applies to the roots. Although roots cannot perform photosynthesis, its role is still very crucial in maintaining the well-being of plants. It absorbs water and nutrients from soils and supplies it to the whole plants for their metabolic activities. Roots also give plants mechanical support. Environmental factors that influence plant root growth are soil temperature, soil moisture content, solar radiation and the physical, chemical and biological properties of the soil. When environmental conditions are favourable, smaller root system or less vigorous root system can produce maximum economic yield (Fageria., 2013).

Soil plays a very important role in the growth of any plant. Soil is defined as a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by one or both of the following: horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment. Thus, people consider soil as very important because it can support plants that supply food, fibres, drugs and much more. (Soil Survey Staff., 1999). Soils are divided into three main texture categories, namely clay, sand and silt. As they differ in texture, clay has the tiniest particles while sand has the largest. The size of sand particles range between 2.0 and 0.05 mm; silt, 0.05 mm and 0.002 mm; and clay, less than 0.002 mm. This is due to the type of parent material and the degree of weathering and due to these differences, these soils differ in many aspects such as water holding capacity, pH level, porosity, nutrient retention and supply, drainage, and nutrient leaching. However, both clay and sandy soils can sometimes be problematic to plants, hence adding soil amendment is a solution to the problems.

Soil amendment is a general term used for any material mixed into soils as a means to improve its quality. This includes organic fertilizers that is defined as any material derived from only natural resources which provide many benefits toward soils. It can affect both the physical and chemical properties of soil. Organic fertilizer is often favoured over chemical fertilizer because it is thought to be less harmful to the environment especially to soil health, compared with chemical fertilizers that have long term harmful effects to the environment. There are many types of organic fertilizer such as empty fruit bunch (EFB) compost, chicken manure, vermicompost and others.

1.2 Justification of study

Soil texture always plays a significant role in the growth of plants. Both clay and sand can sometimes be very problematic. Clay is generally plastic at an inadequate water content condition and will harden when dried. Due to this aspect, many plants can't grow well in this type of soil. It restrict the growth of roots, water logging and many more. As for sandy soil, it is the total opposite of clayey soil. It drain quickly and are much more easier to cultivate and work at. However, on the downside, sandy soil dries too rapidly that it won't hold water and are very low in nutrients due to being washed out by rain. It is also often very acidic which is also not good for planting plants. Both of these soil type, can really alter the growth of plants, it can affect the roots penetration and density, which in turn can affect the nutrients and water uptake. Thus, the well-being of overall plants could be affected.

Unfertile conditions, can really affect and limit plant growth. Sadly, bad soils can be found easily in Malaysia and people always fix this problem via the application of chemical fertilizers. However, little do they know that the long term effect of using chemical fertilizer can be hazardous to both human and nature. In view of this, organic fertilizers or amendments are chosen to be added into both of the problematic soils mentioned earlier in the hope that this can improve the soil's condition and fertility without damaging the environment. EFB compost was also specifically chosen because it is something easily available and in abundance. Next, compost are cheaper than chemical fertilizer. Hence, this study is conducted to learn more about its economic benefits and its environmental friendliness. In is hoped that this study, can be of use to rural people by coming up with an alternative cheaper soil conditioner. This study will involve observing the roots, for roots often give an indication on how fertile the soil is. Lastly, this study is conducted due to the knowledge gap about purslane when associated with EFB compost especially when planted on different kinds of soil texture.

1.2 Objectives

1. To evaluate the effect of EFB compost on the yield of purslane on sandy and clay soil.
2. To evaluate the effect of EFB compost on the root characteristics of purslane on sandy and clay soil.
3. To evaluate the effect of EFB compost on selected soil properties.

1.3 Hypotheses

H_o: There is no significant difference in the effect of organic fertilizer on the root characteristics and yield of Purslane

H_a: There is a significant difference in the effect of organic fertilizer on the root characteristics and yield of Purslane.

CHAPTER 2

LITERATURE REVIEW

2.1 Purslane

Common purslane, *Portulaca oleracea L* is commonly known as Lunak or Kulfa, or an english name of Purslane. It is a member of the portulacaceae family which comprises than 120 different species, for an example, *Portulaca quadrifida L. and Portulaca meridiana L.* This is a common weed of rich soils, mostly associated with sugarcane, maize, cotton and other field crops (Surjit Sing and US Walia, 2010). However, it is also found growing in fallow fields, bare areas, low maintenance lawns and waste areas, as it prefer sandy soils and loose soils but thrives better as well in a place that is well irrigated. Needless to say, this plants is a plant that can grow under wide range of soil conditions, climate and regions as it is found all over Central Europe, Asia and the Mediterranean region. In some regions, purslane is considered as medicinal plants and food plants. However, purslane also falls under the category of weed plants, as it can invade agricultural areas. In fact, this plants is considered as one of the ten most noxious weeds of the world.

Purslane is a C4 plants, and this is why it can stand hot and arid or semi-arid climates, as well as temperate regions. This plant however, cannot stand cold region and its seed will only germinate when the temperature reaches 60F.

2.1.1 Morphology

P. oleracea is mostly an annual, but it may be perennial in the tropics. Its stem is prostrate and glabrous, succulent and often reddish in colour. Arising from a taproot, its stem produces many branches that form a mat on the ground. The leaves are alternate, sub-alternate or opposite or clustered with a simple, obovate to spatulate or wedge shape, entire, thick and fleshy. It may range from 40mm x 15mm up to 60mm x 25mm in a more fertile soil. As for its flower, it has a yellow small flower with axillary and sessile from flattened pointed buds. Flowers are 1 to 1 ½" in diameter and resemble cactus blooms. That can be single or double and most have ruffled petals. They open on sunny days and close at night or when it is cloudy. Usually, it bloom in a group at the end of the stem. The seeds of purslane are very small and slightly glossy black. Seeds are tiny, less than 1/25 of an inch (1 mm) in diameter, circular to egg shaped, flattened, and brown to black with a white point of attachment. This plant produces numerous seeds and this makes purslane so hard to eradicate on fields. It germinates rapidly. Purslane flowers and fruits simultaneously throughout its period of growth (Sing and Walia, 2010).

2.1.2 Usage of Purslane

Although purslane is classified as weeds, yet common purslane is edible. It has a sweet yet acid-like flavour which make it as an excellent crunchy salad plant, and deemed to be an excellent crunchy salad plant and its soft stem and leaves are usually used raw, either alone or with other greens. It is said to blend well with hotter-flavoured salad herbs. Purslane can be consumed both raw and cooked. Other than that, purslane also possess some medicinal value for human health. Its medicinal value is evident from its use for treatment of burns, headache, and diseases related to the intestine, liver, stomach, cough, shortness of breath, and arthritis. Its use as a purgative, cardiac tonic, emollient, muscle relaxant, and anti-inflammatory and diuretic treatment makes it important in herbal medicine. Purslane has also been used in the treatment of osteoporosis and psoriasis. Purslane is also a very good source of alpha-linolenic acid. Alpha-linolenic is an omega-3 fatty acid which plays an important role in human growth and development and in preventing diseases. Purslane has been shown to contain five times higher omega-3 fatty acids than spinach (Uddin et al., 2014). Purslane is also used to prevent some cardiovascular diseases and to maintain a healthy immune system (Simopoulos, 2004). It is also rich in antioxidant vitamins and omega-3 fatty acids (Rahdari *et al.*, 2012). It is listed as one of the most useful medicinal plants and named "Global Panacea" by the World Health Organization (Sultana and Rahman, 2013). Other than for human consumption, purslane is also used as livestock feed such as for sheep and pigs.

2.2 Fertilizers

By definition, fertilizer refers to amendments that can guarantee the minimum percentages of nutrients. In other words, fertilizer is any material of either natural or synthetic origin that is applied to soil or plant tissue to supply one or more plant nutrients that is essential to the growth and well-being of plants. This statement is also supported by Lucius (2003), when he stated that a fertilizer is any substance, which under favourable conditions when added to a soil, will produce better growth of crops, whether through direct or indirect action on the crop or on the properties of the soil. Mainly, fertilizers are divided into two. Organic fertilizer and inorganic fertilizer. An organic fertilizer refers to a soil amendment which is derived from natural sources that guarantees, at least, the minimum percentages of nitrogen, phosphate, and potash. Examples include plant and animal by-products, rock powders, seaweeds, inoculants and conditioner (Small, 2016). Meanwhile inorganic fertilizer, is a soil amendment which is not derived from natural sources, for example NPK BLUE, whereby its Nitrogen nutrients are obtained or produced from Haber-Bosch process.

2.2.1 Organic Fertilizer

Organic matter is the food for most of the flora and fauna responsible for soil biological activities. Proper and ensured management of soil organic matter is the prime requirement for an efficient soil biological system. Farmers since ancient times have recognized the benefits of organic matter for crop productivity and yield. These benefits have been the subject of controversy for centuries and some are still debated until this very day. However, people globally still approve the importance of organic matter and its many recognized benefits like, it serves as a slow-release source of N,P and S for plant nutrition and microbial growth. Next, it possesses considerable water-holding capacity, and thereby helps to maintain the water regime of the soil. It also acts as a buffer against changes in pH of the soil. Its dark colour contributes to absorption of energy from the sun and heating of the soil as well as serving as a *cement* for holding clay and silt particles together, thus contributing to the crumb structure of the soil, and to resistance against soil erosion. Not just that, organic matter also binds micronutrient metal ions in the soil that otherwise might be leached out of surface soils and last but not least, the organic constituents in the humic substance may act as plant-growth stimulants. (Arun, 2003)

2.3 Compost as Organic Fertilizer

Composting is one of the methods in which some of the problems associated with the utilization of various organic wastes can be resolved. Composting practice dates way back to ancient times. It is a practice whereby farmers convert organic wastes into resources that provide nutrients to crops and enhances soil tilth, fertility and productivity. Composting is a natural process that turns organic material into a dark rich substance, a wonderful conditioner for soil. During composting microorganisms such as bacteria and fungi break down complex organic compounds into simpler substances and produce carbon dioxide, water, minerals and stabilized organic matter (compost). The process produces heat, which can destroy pathogens (disease causing microorganisms) and weed seeds.

Compost provide a more stabilized form of organic matter to soil then the raw wastes and it can enhance the physical properties of soils (Sharma., 2009). For example, addition of compost to sandy soils will increase their ability to retain water and render them less droughty. Meanwhile, in heavy textured clay soils, the added organic matter will increase permeability and water infiltration and it can reduce the soil compaction, lower the bulk density and increase the rooting depth.

2.3.1 Empty Fruit Bunch Compost

The oil palm industry is a massive industry in Malaysia. With Malaysia as the second largest oil palm producer of the world next to Indonesia, this shows how big this industry is in Malaysia. According to MPOC, Malaysia currently accounts for 39 % of world palm oil production and 44% of world exports. It contributes about US$ 7.3 billion in export earnings per year. This mega industry, produces more than 90 million mt of renewable biomass per year and this includes Empty Fruit Bunches whereby, EFB makes up about 9% of the whole constituent (Bari *et al.,* 2010).

EFB or Empty Fruit Bunches is the by-product produced during the extraction process of oil palms main products, Crude Palm Oil (CPO) and Crude Palm Kernel Oil (CPKO). EFB is a lignocellulosic material which typically contains 25% lignin, 50% cellulose and 25% hemicellulose in their cell walls. However, in the past year before EFB was used as compost and mulch, it was first used as fuel to generate steam in the oil palm industries, however, it was strictly restricted due to air-pollution concerns from such activities. Nowadays, EFB compost is the most suitable option amongst the waste management strategies with economic and environmental profits since this process reduces the bulk volume of the organic materials, eliminates the risk of spreading of pathogens, weed seeds or parasites and can improve and sustain soil fertility (Kavitha, *et al.*2013). Organic fertilizers like EFB compost have the potential to correct almost all negative impacts of mineral fertilizers on soil as well (AdeOluwa. 2008).

2.3.2 EFB Compost Properties

Basically all compost are dark brown and blackish brown in colour. Particle sizes are mainly divided into three; Coarse Mulch - at least 70% of the material is larger than 16 mm. Fine Mulch- between 20% and 70% of the material is larger than 16 mm and lastly, soil Conditioner - less than 20% of the material is larger than 16 mm. Mulches are used for surface application while soil conditioners are incorporated into the soil. Coarse textured material is the most appropriate for use as mulch. It has larger woody particles, which help water and air reach the soil easily. Finer textured materials tend to have a higher nutrient content and can act faster to improve soil structure and water holding capacity but they can also reduce infiltration, preventing water from reaching the soil.

2.4 EFB Compost Application to Soil

Due to its many attributes, compost is extremely versatile and beneficial in many applications. Composting helps to optimise nutrient management and the land application of compost may contribute to combat soil organic matter decline and soil erosion (Van Camp et al, 2004). Compost land application completes a circle whereby nutrients and organic matter which have been removed in the harvested produce are replaced (Diener et al ,1993).The recycling of compost to land is considered as a way of maintaining or restoring the quality of soils, mainly because of the fertilizing or improving properties of the organic matter contained in them. Furthermore, it may contribute to the carbon sequestration and may partially replace peat and fertilizers (Smith et al, 2001). Other than that, the presence of decomposing and decomposed organic matter in agricultural soil is essential as an aid in furnishing conditions which enable crops to use applied fertilizers most efficiently. (Lucius L. 2003). Soil structure can also be improved by the binding between soil organic matter and clay particles via cation bridges and through stimulation of microbial activity and root growth (Farrell and jones, 2009). According to Tisdall and Oades (1982), organic matter can indirectly improve soil structure by increasing microbial activity and thus production of microbial slimes, fungal hyphae and/or roots to bind aggregates together making organic matter as a significant reservoir of nutrients and can retain nutrients in a plant-available form. Applying EFB Compost to soil, can increase the water holding capacity and plant water availability. (Farrell and Jones, 2009). It can also reduce erosion and leaching of nutrients. Compost application to agricultural land needs to be carried out in a manner that ensures sustainable development (Amlinger et al, 2003). In other words, compost has the unique ability to improve the properties of soils and growing media physically, chemically and biologically.

2.4.1 Effect of EFB Compost on Soil Chemical Properties

The addition of compost to soil can modify the pH of the final mix depending on the pH of the compost and of the native soil, compost addition may raise or lower the soil/compost blend's pH. This is due to the mature compost properties, whereby it has a neutral to slightly alkaline pH (Duong, 2013). Therefore, the addition of a neutral to slightly alkaline compost to an acidic soil will increase the pH if added in appropriate quantities. In specific conditions, compost has been found to affect soil pH even when applied at quantities as low as 10-20 tons per acre. The incorporation of compost also has the ability to buffer or stabilize soil pH, whereby it will more effectively resist pH change.

In addition of the chemical benefits that compost offer, it can also increase cation exchange capacity of soils by enabling them to retain nutrients longer. Hence this will allow crops to effectively utilize nutrients, while reducing nutrients lost by leaching. For this very reason, the fertility of soil is often tied to their organic matter content. This is further supported because compost have a high cation exchange capacity and can therefore increase soil CEC when incorporated. Humic acids, major components of compost can bind cations because they contain carboxylic acid groups, which can bind positively charged multivalent ions (Mg^{2+}, Ca^{2+}, Fe^{2+}, Fe^{3+}, trace elements, but also Cd^{2+} and Pb^{2+}) (Pedra *et al.,* 2008). Next, improving the cation exchange capacity of sandy soils by adding compost can greatly improve the retention of plant nutrients in the root zone.

Compost products contain a considerable variety of macro and micronutrients. Although often seen as a good source of nitrogen, phosphorous and potassium, compost also contains micronutrients essential for plant growth. Since compost contains relatively stable sources of organic matter, these nutrients are supplied in a slow-release form. Most essential nutrients in compost are in organic forms which are released slowly and are less subject to leaching compared to inorganic fertilisers (Larney *et al.,* 2008). On a pound by pound basis, large quantities of nutrients are not typically found in compost in comparison to most commercial fertilizers. However, compost is usually applied at much greater rates; therefore, it can have a significant cumulative effect on nutrients availability. The addition of compost can affect both fertilizer and pH adjustment (lime/sulphur addition). Compost not only provides some nutrition, but often makes current fertilizer programs more effective.

2.4.2 Effect of EFB Compost on Soil Physical Properties

Sandy soil is made up of particles having the size of sand. The relative large sized particles result in large pores between the particles, though the total pores constitute low porosity. The apparent specific gravity or bulk density of soils is generally high, being 1.6-1.8 g/cm^3, while that of clay soils is only 1.4-1.5 g/cm^3.

The drainable pore volume refers to the volume of water released or taken by a unit volume of soil in the zone which may be under the influence of a fluctuating water table. Sandy soils have a high content of large pores which results in larger channels for water conveyance. Thus, these soils have good drainage. Also, because water is usually retained in the narrow pores and not in the large ones, little amount of water may be retained in sandy soils. Since the sandy soil contain a higher proportion of air at the expense of their content of moisture, the air penetration through these soils decreases with the decrease in the size of particles.

Dark, clayey soils that shrink and swell upon drying and wetting are found on every continent except Antartica. The central concept of Vertisols is that of clayey soils that have deep, wide cracks for some time during the year and have slickensides within 100 cm of the mineral soil surface. They shrink when dry and swell when moistened. Vertisols make up a relatively homogeneous order because of the amounts and kinds of clay common to them; however, their microvariability within a pedon is great. Before the advent of modern classification systems, these soils were already well known for their characteristic color, the cracks they produce during the dry season, and the difficulty of their engineering properties. These soils generally are sticky in the wet season and hard in the dry season.

According to the US Composting Council (2001), the physical benefit of applying compost (including EFB Compost) is that it can improve the structure of soil, whereby, compost can greatly enhance the physical structure of soil. Particularly in clay soil, the addition of compost can reduce the bulk density and improve its friability (workability) and porosity, and increase its fluid permeability, thus reducing soil erosion. With this improvement, plants can establish and grow better. Other than that, with this benefits that it offers, compost can also prevent or resist further compaction in fine-textured soil and increase water holding capacity and improve soil aggregation in coarse-textured soils. (Farrell and Jones, 2009). This is due to the binding properties that compost possess; its humus content. Humus is a stable residue that may result from a high degree of organic matter decomposition. Humus act like a soil glue that hold the soil particle together, making them more resistant to erosion and improving the soil's ability to hold moisture.

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