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Assessment of Soil Organic Matter Determination Techniques in Tropical Soils: Correlation Among Four Methods as Indicators of Plant Growth Potential

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Abstract

Soil organic matter (SOM) is a key indicator of soil fertility, yet variability among analytical methods limits its reliable interpretation, particularly in tropical soils. This study evaluated four SOM determination methods—Walkley–Black (WB), loss on ignition (LOI), colorimetric (COL), and hydrogen peroxide (HP)—and examined their relationships with maize growth under contrasting parent materials in southwestern Nigeria. Soil samples were analyzed for organic matter content and subsequently used in a screenhouse to assess plant height, stem girth, and dry matter yield of maize. The result indicated that the organic matter determined was in the order of HP > LOI > COL > WB. Parent material affected the organic matter content, as soils from sedimentary parent material had higher organic matter than soils from the basement complex. A strong, significant relationship was observed among these methods as their R^2 ranged from 0.9028 to 0.9686, though COL and LOI correlated best with each other. The regression equations are WB = 0.9041 (COL), WB = 0.8187 (LOI), COL = 0.9141 (LOI), HP = 5.0597 (LOI), WB = 0.1555 (HP), and COL = 0.1667 (HP). Colorimetric method correlated very significantly with all agronomic parameters during the vegetative stage (2 – 6 weeks after planting), whereas WB correlated best with the agronomic parameters at the reproductive stage (8WAP). The order of relationship between organic matter methods and dry matter was WB > HP > COL > LOI; a similar order was observed for plant height. It is therefore concluded that the Walkley Black method could be used as a reliable index for predicting crop response in tropical soils.

Keywords: Regression equation, Soil organic matter index, Dry matter, Colorimetric organic matter

1.0. Introduction

Soil organic matter (SOM) is a crucial component of soil health, quality, and productivity, and represents a major terrestrial carbon (C) pool linked to global climate change. (Bogunovic et al., 2018; Six and Paustian, 2014). SOM underpins soil productivity by acting as a reservoir of nutrients for plants and soil organisms, while also regulating water retention and soil aeration necessary for healthy plant growth. It can significantly influence plant fertilizer requirements, as it supplies more than half of the N and P needed throughout a plant's life cycle (Doll and Snapp, 2009). The effect of SOM on the soil cannot be overemphasized as it also reduces erosion, increases elasticity, compatibility, porosity, and water retention (Sellami et al. 2008, Paradelo and Barral 2013). Subsequently, from the above, the determination of SOM, a key indicator of soil quality, is important for soil characterization (Idowu et al. 2008).

Soil organic matter is made up of plant, animal, and microbial-derived organic residues that are at varying stages of humification or decomposition (Hur et al. 2013). Though the structure of SOM is variable with various carbon functional groups of inorganic and organic complex compounds (Shi et al. 2006), it is a major global carbon pool that serve as a sink for about three times carbon than the atmosphere or any living organism (Brevik 2012). SOM can also contain traces of other elements with less abundance than carbon and hence are not used for the estimation of soil organic matter.

To understand the local fertility of a soil, the determination of SOM to determine the level of soil function and quality is important (Franzluebbers 2002, Doran and Zeiss 2000; Idowu et al. 2008). Subsequently, SOM is made up of various C compounds; several methods have been developed to measure SOM as well as its constituent compounds. Hence, the measurement of SOM is generally done by determining the carbon content through dry or wet oxidation procedures. A common dry oxidation method is loss on ignition (LOI), which involves the use of thermal energy to decompose SOM in a muffle furnace (Roper et al. 2019), leading to loss of SOM due to oxidation and volatilization. This method is widely adopted to determine organic C contents in soil due to simplicity and cost (Wang et al. 2011).

Other methods of SOM determination involve the use of wet oxidation procedures like the hydrogen peroxide method, the colorimetric method, and Walkley Black method. The hydrogen peroxide method involves the continuous digestion of soil or sediment with a concentrated hydrogen peroxide with or without the addition of heat until frothing ceases in the sample. This several limitations that markedly reduce its effectiveness to quantify organic matter and total organic carbon and thus making it a semi-quantitative method at its best (Bissey et al. 2007).

Soil organic matter can also be determined by several other methods that quantify a particular fraction of SOM related to a particular carbon compound in the SOM carbondioxide (Roper et al. 2019), some of such method involve the quantification of microbial respiration which releases, permanganate oxidation of soil organic carbon (Weil et al. 2003) which measures labile soil organic carbon are used to measure labile soil organic carbon (SOC). Furthermore, recalcitrant soil organic carbon can also be measured as a representative of SOM, since it is a form of SOM that can stay in the soil for a long time. Methods used to measure recalcitrant SOC are varied in their approach, and one of such methods is the Walkley and Black (WB) method, developed to measure recalcitrant SOC with a chemical oxidant (Walkley and Black 1934; Walkley 1947; Nelson and Sommers 1996).

The Walkley and Black method of organic matter determination is the most widely used (Walkley and Black, 1934) and it involves the oxidation of SOC with a chromic acid generated in situ with a mixture of potassium dichromate and sulphuric acid after which the measured SOC is converted to total organic carbon by a correction factor of 1.30 and then the total organic carbon is then recalculated into humus or organic matter using the mean coefficient (1.724) or experimentally determined coefficients (Nelson and Sommers 1982).

Soil Organic matter can also be determined colorimetrically according to the method reported by Olowoboko et al. (2019). The colorimetric method of organic matter determination involves the oxidation of SOC with a chromic acid generated insitu with a mixture of potassium dichromate and sulphuric acid, after which the organic carbon is determined colorimetrically with barium chloride on a UV/V spectrophotometer at 600nm.

In the comparison of SOM values from different methods such as WB, LOI and colorimetry, there exist a variation in the reactivity and composition of SOM that causes inconsistencies in the measured values, thereby affecting SOM investigation (Roper et al. 2019) and thus making the interpretation of SOM values from SOC measurement difficult. For instance, a conventional way is the assumption that SOM contains 58 % of SOC (Bianchi et al. 2008), but some authors have reported that SOC ranges from 50 to 66% of SOM (Périé and Ouimet, 2008; Pribyl 2010). This disparity in the composition of soil organic matter further compounds the problem of estimation of SOM from SOC measurements.

The direct measurement of bulk SOM by the LOI procedure is common due to cost, popularity, and simplicity (Luke et al. 2009, Salehi et al. 2011); however, some studies have reported that the measurement of bulk SOM cannot be used alone due to its limitations (Koarashi et al. 2005, Salehi et al. 2011). Despite the availability of multiple SOM determination methods, their comparative performance and relationship with crop response under tropical soil conditions remain poorly understood. In particular, limited information exists on how these methods relate to plant growth dynamics across different parent materials. This knowledge gap constrains the selection of appropriate SOM indices for agronomic decision-making in tropical environments.

The intensification of methods that precisely determine soil organic carbon, suitable for use by most soil analysis laboratories, is in practice today. Yet, there is a need for proper understanding and evaluation of a wide range of soils under different parent materials. This study uniquely integrates laboratory-based SOM determination methods with agronomic evaluation, providing a direct assessment of how different SOM indices relate to crop performance in tropical soils. Hence, the objectives of the study are to

(a) Evaluate the organic matter methods in some tropical soils under different parent materials and locations.
(b) Evaluate the effect of location and parent materials on the agronomic parameters (plant height, stem girth) and yield of maize
(c) Determine the relationship between the four methods for organic matter determinations.
(d) Determine the relationship between four analytical methods of organic matter and maize agronomic parameters at the vegetative phase (2 - 6 weeks after planting) and reproductive phase (8 weeks after planting).

2.0. Materials and Methods

2.1. Soil sample collection and preparation

Ten bulk samples were collected per location at a depth of 0 - 15cm, (the samples were mixed thoroughly to make a composite sample) from nine locations each from basement complex and Sedimentary parent materials of Nigeria. Table 1 shows the location based on parent materials and the location on the map. The samples were air dried, after which they were sieved with a 2mm sieve for initial soil analysis.

2.2. Soil Analysis

Soil samples were analyzed for selected physicochemical properties. Soil pH was determined in a 1:1 soil-to-water suspension using a glass electrode pH meter (Hanna instruments, HI 2211 pH meter) following the method of Udo et al. (2009). Particle size distribution was determined using the Bouyoucos ASTM 152H Hydrometer (Udo et al., 2009). Total nitrogen was determined using the micro-Kjeldahl method (Gerhardt Kjeldahl Digestion Unit) according to Jackson (1962). Available phosphorus was extracted using Bray-1 solution and determined colorimetrically (AOAC, 2010). Exchangeable cations were extracted with 1 M NH_4OAc (pH 7.0), with the concentrations of K and Na measured using flame photometer (Sherwood 410 Flame Photometer), while concentrations of Ca and Mg were determined using atomic absorption spectrophotometry (Buck Scientific 210 VGP AAS) (Sparks, 1996). Organic carbon was determined using the dichromate method (Walkey and Black 1934). Organic matter was gotten by multiplying the percent organic carbon by 1.724.

2..3. Organic matter characterization

The laboratory experiment was arranged in a completely randomized design (CRD) with four treatments (SOM determination methods) and three replicates per soil sample. The treatments were four methods of soil organic matter determination, which were: Walkley-Black Titration, loss on ignition, digestion with H_2O_2, and the Colorimetric method.

2.3.1. Colorimetric Method

Organic carbon was determined colorimetrically according to Olowoboko (2019); A standard carbon solution was prepared, and calibration standards (0, 5, 10, 20, and 25 mg L^{-1}) were used. One gram of finely ground soil (<0.5 mm) was weighed into a conical flask, followed by the addition of 10 mL of 5% potassium dichromate. Subsequently, 20 mL of concentrated sulfuric acid was added, and the mixture was allowed to cool before adding 50 mL of 0.4% barium chloride. The solution was left to stand overnight, and absorbance was measured at 600 nm using a UV–Vis spectrophotometer Organic carbon concentration was determined by plotting a graph of the standard's absorbance with their concentration. The organic matter content was determined by multiplying the concentration of organic carbon by 1.724.

2.3.2. Hydrogen Peroxide Digestion Method

Three grams of soil were placed in a 250 mL beaker, and 15 mL of 50% hydrogen peroxide (H_2O_2) was added. The mixture was heated on a steam bath with continuous stirring until frothing ceased. The sample was then dried at 105 °C, cooled, and weighed. Organic matter content was calculated as:

$$\%\text{ weight loss on } H_2O_2 = \frac{(\text{Initial weight}) - (\text{Final weight}) * 100}{\text{Initial weight}}$$

2.3.3. Walkley and Black method

A 0.5 g air-dried soil sample (<0.5 mm) was weighed into a conical flask. Ten millilitres of potassium dichromate were added, followed by 20 mL of concentrated sulfuric acid. The mixture was allowed to stand for 30 minutes before dilution with distilled water. After adding ferroin indicator, the solution was titrated with 0.5 N ferrous ammonium sulfate. Organic carbon was calculated as follows, and organic matter was determined by multiplying the percent organic carbon by 1.724.

$$\% \text{ O.C} = \frac{(B-T) * 0.5N * 0.003 * 1.33 * 100}{\text{Soil weight}}$$

B is blank titre value, T is sample titre value

2.3.4. Weight Loss on Ignition

This was determined according to the method of Dean (1974). Ten grams of soil samples was weighed and oven dried in a murfle furnace at 105^0C to remove moisture. The samples were weighed again, then heated at 360^0C for 2 hours. The heated samples were weighed after the temperature dropped below 105^0C. Organic matter was calculated as follows:

$$\% \text{ LOI} = \frac{(\text{Weight at } 105^0\text{C}) - (\text{Weight at } 360^0\text{C}) * 100}{\text{Weight at } 105^0\text{C}}$$

2.4. Screen House Experiment

One kilogram of each soil sample was placed in plastic pots and arranged in a completely randomized design with three replicates. Two seeds of maize (Oba Super 2 hybrid) were planted per pot and later thinned to one plant. Pots were watered regularly to maintain adequate moisture under screenhouse conditions and observed for a duration of eight weeks. The growth parameters measured were plant height and stem girth. The plants were also harvested and oven dried at 65^0 C for dry matter yield.

2.5. Statistical Analysis

Data obtained was subjected to analysis of variance (ANOVA) using SAS version 20.0 statistical package and the difference between significant mean values was evaluated at $p < 0.05$ probability level using Duncan Multiple Range test. Correlation and Regression analysis were also carried out to determine the relationship among soil organic carbon methods and agronomic parameters.

3.0. Results and discussion

3.1. Characterization of soils

The soils used for the experiment were collected from locations belonging to the basement complex and sedimentary parent rock (Table 2). The pH of the soils ranged from 4.77 in SED Soil 1 to 8.09 in SED Soil 4, as shown in Table 2. Among soils collected from sedimentary parent materials, soils from SED Soil 1 and SED Soil 9 had very strongly acidic pH, while the pH of SED Soil 4 was moderately alkaline. The pH of soils from basement complex materials was slightly acidic to neutral, except BC Soil 2, BC Soil 6, and BC Soil 7. The higher pH observed in SED Soil 4, BC Soil 6, and SED Soil 2 compared with other locations could be attributed to higher concentrations of exchangeable basic cations in these soils, as reflected in their elevated effective cation exchange capacity (ECEC). Soil pH is strongly influenced by the presence of exchangeable bases such as calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na), which neutralize soil acidity and increase base saturation. Soils with higher concentrations of these basic cations generally exhibit higher pH values and improved buffering capacity, thereby increasing ECEC.

This observation agrees with findings from Nigerian soils, where higher soil pH was associated with increased levels of exchangeable bases and ECEC. For instance, Agbede and Adekiya (2017) reported that soils with higher concentrations of Ca and Mg exhibited increased pH and ECEC values in southwestern Nigeria. The authors noted that the accumulation of basic cations contributes significantly to soil alkalinity and improves nutrient retention capacity. Similarly, Olorunfemi et al. (2018) observed that soils with greater base saturation in derived savanna soils of Nigeria recorded higher pH and ECEC, indicating that exchangeable base content is a major determinant of soil reaction and cation exchange properties. Furthermore, Akinrinde and Obigbesan (2000) reported that variations in soil pH across different Nigerian soils were largely influenced by differences in exchangeable basic cations, with soils containing higher Ca and Mg showing higher pH and improved cation exchange capacity.

Total nitrogen was moderately high in soil from BC Soil 2, whereas nitrogen content in the remaining soils ranged from low to medium. The generally low to moderate nitrogen status observed in most of the soils may be attributed to the inherently low organic matter content and high sand fraction of tropical soils, which promote rapid mineralization and leaching losses of nitrogen (Brady and Weil, 2016; Agbede, 2009). Tropical soils, particularly those derived from sedimentary and basement complex parent materials, are commonly characterized by poor nitrogen reserves due to continuous cultivation, high temperature, and intense rainfall, all of which accelerate organic matter decomposition and nitrogen loss (Sanchez, 2019).

Available phosphorus was lowest in soil from SED Soil 8, whereas other soils exhibited very high phosphorus content. The high available phosphorus recorded in most soils may be attributed to the influence of parent material, previous fertilizer application, and organic matter decomposition, which enhance phosphorus availability in soils (Havlin, 2014). In contrast, the low phosphorus content observed in SED Soil 8 may be due to phosphorus fixation by iron and aluminum oxides, which are common in highly weathered tropical soils (Udo, 2009). Such fixation reduces phosphorus availability to plants and limits crop productivity.

Soils from SED Soil 4 recorded the highest calcium and potassium content. This may be attributed to its proximity to the SED Soil 4 cement company and the associated deposition of calcium-rich dust particles. Cement dust has been reported to increase soil calcium content and alter soil chemical properties through alkaline deposition (Azeez and Adetunji 2004). In addition, cement dust deposition often leads to increased soil pH and enhanced base saturation, which subsequently improves potassium retention in soils (Haynes and Mokolobate, 2001). This explains the elevated calcium and potassium levels observed in soils near industrial activities.

The sodium content of the soils ranged from medium to high, while magnesium content varied from low to medium. The highest magnesium and sodium contents were recorded in SED Soil 2 and BC Soil 5, respectively. Elevated sodium levels in soils may arise from parent material composition, irrigation water quality, or weathering processes (Sumner, 1993). High sodium levels may negatively influence soil structure by dispersing soil particles and reducing infiltration capacity, especially in sandy soils (Brady and Weil, 2016). Similarly, magnesium availability in soils is influenced by weathering of magnesium-bearing minerals and cation exchange processes (Agbede, 2009).

Soils from SED Soil 2 and BC Soil 2 exhibited very high organic matter content. The high organic matter observed in these soils may be attributed to increased organic residue accumulation, reduced disturbance, and favourable environmental conditions for organic matter stabilization. The rate of mineralization, coupled with high crop residue and litter accumulation, likely contributed to the elevated organic carbon levels. This observation agrees with the findings of Amara and Momoh (2014), who reported that organic residue accumulation significantly improves soil organic matter content in tropical soils. High organic matter enhances nutrient availability, improves soil structure, and increases water-holding capacity, thereby promoting soil fertility (Lal, 2015).

All soils derived from sedimentary parent materials exhibited moderate organic matter, except SED Soil 5 and SED Soil 9, which recorded low organic matter. Similarly, BC Soil 9 and BC Soil 1 had moderate organic matter, whereas other basement complex soils, except BC Soil 2, had low organic matter content. The low organic matter observed in most basement complex soils may be attributed to rapid decomposition of organic residues under tropical climatic conditions, low biomass return, and continuous cultivation practices (Sanchez, 2019). Additionally, coarse soil texture in many of these soils reduces organic matter stabilization and promotes rapid decomposition (Brady and Weil, 2016).

Most of the soils used in the experiment were sandy in texture, except soils from BC Soil 9, SED Soil 4, SED Soil 1, and SED Soil 9. Sandy soils are typically characterized by low nutrient retention capacity, low cation exchange capacity, and high permeability (Agbede, 2009). Consequently, there is a high tendency for nutrient leaching in sandy soils, particularly under high rainfall conditions typical of humid tropical environments. This may result in reduced nutrient availability and lower soil fertility compared to finer-textured soils (Havlin, 2014). Therefore, the predominance of sandy texture in most of the soils suggests a need for soil management practices such as organic amendments and split fertilizer application.

3.2. Effect of Location on Soil Organic Matter

The organic matter content as determined by different analytical methods, is shown in Figure 1. The highest organic matter content of the soil varies with the different methods used, although a regular pattern was observed in values among some of the soil locations. Organic matter determined was in the order of hydrogen peroxide > loss on ignition > colorimetric > Walkley Black. The variation observed in organic matter determined using different analytical methods, where hydrogen peroxide recorded the highest values followed by loss on ignition, colorimetric and Walkley–Black methods, can be attributed to differences in oxidation strength and recovery efficiency of each method. Strong oxidizing agents such as hydrogen peroxide are capable of decomposing a larger fraction of soil organic matter, including resistant organic compounds, thereby resulting in higher organic matter values. In contrast, the Walkley–Black method relies on dichromate oxidation, which is known to incompletely oxidize soil organic carbon, leading to comparatively lower estimates of organic matter.

This observation is consistent with findings from Nigerian soils, where variations in organic carbon determination methods have been widely reported. For instance, Olayinka et al. (1998) evaluated oxidation efficiencies of different wet combustion procedures in soils collected from various ecological zones in Nigeria and reported that the Walkley–Black method did not fully oxidize soil organic carbon, thereby producing lower organic carbon values compared with stronger oxidation methods. These differences were attributed to the limited oxidation capacity of dichromate digestion relative to more aggressive oxidation techniques. Similarly, Mustapha (2020) compared loss-on-ignition, tube digestion, and Walkley-Black methods for soils in the Northern Guinea Savanna of Nigeria and reported significant variation among methods due to differences in carbon recovery efficiency. The study indicated that alternative methods, such as loss-on-ignition often produced higher organic carbon estimates compared with Walkley-Black, further supporting the variability observed among analytical procedures. In another study, Mustapha and Muhammad (2023) compared four methods of organic carbon determination, including Walkley-Black and loss-on-ignition, and observed that different methods produced varying organic carbon values due to differences in oxidation completeness and methodological sensitivity. The authors concluded that combustion-based methods generally yielded higher organic matter values compared with wet oxidation procedures.

Moreover, parent material also influenced the organic matter content of the soils, as soils derived from sedimentary parent materials generally recorded higher organic matter than those formed from basement complex rocks. The higher organic matter content observed in soils from sedimentary formations may be attributed to favourable climatic conditions, particularly higher rainfall and temperature, which promote vegetation growth and enhance the accumulation of organic residues on the soil surface. These residues subsequently undergo decomposition, contributing to increased soil organic matter levels. This was evident in soils from Ogun and Lagos States (sedimentary parent materials), which recorded higher organic matter content compared with soils from Kwara and Oyo States derived from basement complex formations.

In addition, sedimentary soils are often characterized by relatively deeper profiles and improved moisture retention compared to basement complex soils, thereby supporting higher biomass production and organic matter accumulation (Brady and Weil, 2016). Conversely, soils formed from basement complex rocks are generally shallow, coarse-textured, and well-drained, which enhances rapid mineralization and decomposition of organic matter, leading to lower organic carbon levels (Agbede, 2009). Many studies have provided evidence that the retention or incorporation of crop residues may increase carbon input while decreasing the soil's carbon loss rate (Nwite and Alu, 2017). Agricultural and other land use practices have a significant influence on the amount and duration of carbon sequestration in the soil before it is returned to the atmosphere (Anikwe, 2010).

Organic matter values varied among soils depending on the analytical method employed. Using the Walkley–Black method, the highest organic matter content of 2.67 % was recorded in BC Soil 8, while the lowest value of 1.72 % was observed in BC Soil 7. For the colorimetric method, the highest and lowest organic matter values were 3.69 % in SED Soil 2 and 1.46 % in BC Soil 6, respectively. When organic matter was determined using the hydrogen peroxide method, the highest value of 21.82 % was recorded in SED Soil 1, whereas the lowest value of 10.00 % was observed in SED Soil 9. Similarly, the loss on ignition method recorded the highest organic matter content of 3.88 % in BC Soil 2 and the lowest value of 1.01 % in BC Soil 6.

The order of organic matter determined using the Walkley–Black method for basement complex soils followed the trend: BC Soil 8 > BC Soil 3 > BC Soil 2 ≈ BC Soil 9 ≈ BC Soil 5 ≈ BC Soil 1 ≈ BC Soil 4 > BC Soil 6 > BC Soil 7, while sedimentary soils followed the order: SED Soil 7 > SED Soil 8 ≈ SED Soil 2 ≈ SED Soil 4 ≈ SED Soil 6 ≈ SED Soil 3 > SED Soil 5 > SED Soil 9. For the colorimetric method, SED Soil 2 and BC Soil 2 did not differ significantly. The ranking for sedimentary soils was SED Soil 2 > SED Soil 4 ≈ SED Soil 6 ≈ SED Soil 1 ≈ SED Soil 5 ≈ SED Soil 8 ≈ SED Soil 7 ≈ SED Soil 3 > SED Soil 9, while basement complex soils followed BC Soil 2 > BC Soil 8 ≈ BC Soil 3 ≈ BC Soil 9 ≈ BC Soil 5 ≈ BC Soil 1 > BC Soil 4 ≈ BC Soil 6 ≈ BC Soil 7.

A different pattern was observed for the hydrogen peroxide method. Sedimentary soils followed the order SED Soil 1 ≈ SED Soil 8 > SED Soil 2 ≈ SED Soil 4 ≈ SED Soil 6 ≈ SED

Soil 3 ≈ SED Soil 5 ≈ SED Soil 7 > SED Soil 9, while basement complex soils followed BC Soil 4 ≈ BC Soil 1 ≈ BC Soil 2 ≈ BC Soil 9 ≈ BC Soil 5 ≈ BC Soil 8 ≈ BC Soil 3 ≈ BC Soil 6 > BC Soil 7. For the loss on ignition method, basement complex soils followed the order BC Soil 2 > BC Soil 8 ≈ BC Soil 9 ≈ BC Soil 5 ≈ BC Soil 1 ≈ BC Soil 4 > BC Soil 3 ≈ BC Soil 7 ≈ BC Soil 6, whereas sedimentary soils followed SED Soil 2 ≈ SED Soil 1 ≈ SED Soil 7 ≈ SED Soil 4 ≈ SED Soil 6 ≈ SED Soil 5 ≈ SED Soil 3 ≈ SED Soil 8 > SED Soil 9.

The variation in organic matter values obtained using different analytical methods highlights the influence of methodological differences on soil organic matter determination. The Walkley–Black method typically measures only a fraction of total organic carbon because incomplete oxidation occurs during analysis, resulting in comparatively lower organic matter values (Nelson and Sommers, 1996). Similarly, the colorimetric method is sensitive to soil composition and organic carbon forms, which may explain the differences observed among soils. In contrast, the hydrogen peroxide method often produces higher values because it removes organic matter more completely, including resistant organic fractions (Ball, 1964). The loss on ignition method also tends to provide relatively higher estimates due to possible inclusion of structural water loss from clay minerals and carbonates during heating (Schulte and Hopkins, 1996).

Furthermore, the differences in ranking among soils across methods suggest that soil mineralogy, texture, and organic residue composition influence organic matter estimation. Soils derived from sedimentary parent materials generally recorded higher organic matter values, which may be attributed to improved moisture retention, greater biomass production, and favourable climatic conditions that promote organic matter accumulation (Brady and Weil, 2016). In contrast, basement complex soils typically recorded lower organic matter values, possibly due to their coarse texture, shallow depth, and rapid organic matter mineralization under tropical conditions (Agbede, 2009). These findings emphasize that the choice of analytical method significantly affects soil organic matter estimation and interpretation of soil fertility status.

3.3. Effect of Location on Maize Agronomic Parameters and Yield

Table 4 shows the plant height of maize grown on soil from the different locations. However, maize height varied across the locations; soils from SED Soil 2 and BC Soil 4 had the tallest and shortest maize plants, respectively, for the first 6 weeks in the period of observation. The higher content of nutrients (total nitrogen, organic matter, and available P) as compared to other soils from sedimentary could have been the reason for the tallest height of maize plants grown in soil from SED Soil 2. Schlegel (1992) observed that increased plant height may be attributed to its high content of nitrogen, phosphorus, and potassium. At 2 weeks after planting, the tallest maize was found in sedimentary soil (SED Soil 2) as 26.1cm, even though this did not significantly differ from maize grown on soils from SED Soil 8, BC Soil 8, and SED Soil 6.

Growth parameters of maize varied significantly across soils derived from basement complex and sedimentary parent materials, reflecting the influence of inherent soil properties on plant performance. At the early growth stage, the height of maize grown on all basement complex soils, except BC Soil 8, did not differ significantly from each other. However, significantly shorter maize plants of 12.73 cm and 14.87 cm were observed in soils from BC Soil 4 (basement complex) and SED Soil 9 (sedimentary), respectively, when compared with other soils from the same parent materials. The poor performance of maize grown on SED Soil 9 could be attributed to its acidic pH, which may have reduced nutrient availability. Additionally, the low exchangeable cations, total nitrogen, and organic matter contents recorded in this soil may have further limited plant growth. Acidic soils often reduce nutrient availability, particularly nitrogen, phosphorus, calcium, and magnesium, thereby restricting plant growth and development (Brady and Weil, 2016). Similarly, Alade et al. (2019) reported that higher nitrogen content significantly increased plant height in maize due to enhanced vegetative growth and leaf development.

At 4 weeks after planting, soils derived from sedimentary parent materials did not differ significantly in terms of maize height, except for SED Soil 2 and SED Soil 9. A significant increase of 40 % in plant height was recorded in maize grown on soil from SED Soil 2 compared with SED Soil 9. The superior performance of SED Soil 2 may be linked to its higher nutrient status, particularly nitrogen and organic matter, which enhance vegetative growth and biomass accumulation. Nitrogen plays a critical role in chlorophyll formation, photosynthesis, and vegetative growth, resulting in increased plant height and biomass (Havlin, 2014).

At 6 weeks after planting, maize grown on soils from SED Soil 2, BC Soil 5, and SED Soil 1 recorded significantly taller plants compared to other soils. Among basement complex soils, BC Soil 5 produced the tallest plants (61.10 cm), while BC Soil 4 recorded the shortest plants (33.53 cm). Similarly, among sedimentary soils, SED Soil 1 and SED Soil 9 recorded the tallest (68.88 cm) and shortest (38.74 cm) plants, respectively. These variations suggest that soil fertility status, particularly nitrogen content, organic matter, and exchangeable bases, played a major role in determining plant height. Soils with higher nutrient availability often promote vigorous vegetative growth and improved plant development (Agbede, 2009).

The stem girth of maize increased progressively throughout the observation period, indicating continuous vegetative growth. Soil from SED Soil 2 consistently produced significantly wider maize stem girth at most sampling periods, except at 4 weeks after planting, whereas the narrowest girth was observed in maize grown on soil from SED Soil 9. At 2 weeks after planting, maize stem girth did not differ significantly among basement complex soils, although slight variations were observed. A similar trend was recorded for sedimentary soils, where maize grown on soil from SED Soil 2 recorded a 30 % increase in stem girth compared with SED Soil 9. The wider stem girth observed in SED Soil 2 may be attributed to improved nutrient availability and better soil physical conditions that supported root development and nutrient uptake (Olowoboko, 2017).

At 4 weeks after planting, soils from SED Soil 2 and SED Soil 8 recorded significantly wider maize stem girth compared with other sedimentary soils. For basement complex soils, BC Soil 6, BC Soil 2, and BC Soil 5 produced maize plants with similar stem girth. The highest stem girth was recorded in BC Soil 2, suggesting favourable soil fertility conditions. At 6 weeks after planting, stem girth remained significantly higher in soil from SED Soil 2 compared with other sedimentary soils, while the lowest value of 1.43 cm was recorded in SED Soil 9. Among sedimentary soils, SED Soil 8, SED Soil 6, and SED Soil 4 were similar, while SED Soil 3, SED Soil 5, and SED Soil 7 did not differ significantly. For basement complex soils, stem girth in BC Soil 2 was significantly higher, representing a 25 % increase over the lowest value recorded in BC Soil 4. At 8 weeks after planting, maize stem girth in soils from all locations was significantly lower than that recorded in SED Soil 2, further emphasizing the superior fertility status of this soil.

The dry matter yield of maize also varied significantly among soils. The highest dry matter yield (2.20 g) was recorded in soils from SED Soil 2 (sedimentary) and BC Soil 5 (basement complex), while the lowest value (0.23 g) was recorded in soil from SED Soil 9. The higher dry matter yield recorded in SED Soil 2 may be attributed to its higher nitrogen content and improved nutrient availability. Nitrogen is essential for vegetative growth and biomass accumulation in maize, thereby influencing dry matter yield (Olowoboko, 2017). Furthermore, soils from sedimentary parent material differed significantly in dry matter yield, indicating variability in fertility status among locations. A similar trend was observed among basement complex soils, although soils from Odeda and Ayetoro did not differ significantly. These findings demonstrate that soil fertility characteristics, particularly nitrogen content, organic matter, and exchangeable bases, played a crucial role in determining maize growth performance and dry matter yield across the different soils.

3.4. Relationship among methods for organic matter determination

Measurement of SOM has been a common procedure in soil science. Many methods are available, each with advantages and disadvantages in terms of accuracy, expense, and convenience (Chatterjee et al. 2009). The relationship among methods for organic matter determination is presented in Figure 1. The R^2 for the relationship between Walkley Black and Colorimetric was 0.929, Walkley Black and Loss on Ignition was 0.9152, Colorimetric and Loss on Ignition was 0.9686, Hydrogen peroxide and Loss on Ignition was 0.9028. A strong, significant relationship was observed among these methods as their R^2 ranged from 0.9028 to 0.9686, though the Colorimetric method and Loss on Ignition correlated best with each other. In a study conducted by Wang, Wang, and Zhang (2012), a strong relationship between SOC and LOI was observed in the calcareous soils tested when comparing three methods for Organic and Inorganic Carbon in calcareous Soils of northwestern China**.** Our results demonstrated that the amount of organic matter obtained differed among the studied methods, but were highly correlated with each order, which is in agreement with Pereira et al. (2006).

Although different methods of measuring SOC have variable results, understanding relationships among results from the methods could assist with interpretations of SOM measured in different ways (Roper et al. 2019). A linear relationship existed among the methods. The regression equations are Walkley black = 0.9041 (colorimetric), Walkley black = 0.8187 (loss on ignition), colorimetric = 0.9141 (loss on ignition), Hydroxide peroxide = 5.0597 (loss on ignition), Walkley Black = 0.1555 (hydrogen peroxide), and Colorimetric = 0.1667 (hydrogen peroxide). This indicates that organic matter measurements could be standardized as the relationship between these methods has been established. This implies that in cases when any of these methods of interest could not be used, the analyst is allowed to adopt any of the other methods, after which the results could then be converted to the desired method through the conversion factor. Roper et al. (2019) reported that correlations between colorimetric measurement of humic matter (HM) and loss on ignition were not significant. However, reports of stronger correlations between HM and LOI has been documented (Strek et al. 1990; Sardessai 1994).

3.5. Relationship among soil organic matter methods and maize agronomic parameters

Table 7 shows the correlation between soil organic matter methods and plant height at 2WAP, 4WAP and 6WAP. It also presented the relationship between soil organic matter methods between stem girth at 2WAP, 4WAP and 6WAP. A significant correlation at existed between colorimetric OM and 2WAP (1 and 5%), 4WAP (0.1, 1 and 5%), 6WAP (1 and

5%), colorimetric OM and stem girth at 2WAP (0.1, 1 and 5%), 4WAP (5%), 6WAP (0.1, 1 and 5%). Walkley Black OM correlated significantly with only plant height at 2WAP (1 and 5%), stem girth at 2WAP (5%) and stem girth at 4WAP (5%). However, no significant relation existed between Hydrogen peroxide method and agronomic parameters except plant height at 6WAP (5%), and stem girth at 6WAP (5%). Loss on Ignition OM had a significant correlation with plant height at 2WAP (5%), 6WAP (5%) and stem girth at 2WAP (0.1, 1 and 5%) and 6WAP (5%).

Figure 2 shows the correlation between Colorimetric OM and maize agronomic parameters (dry matter, plant height and stem girth) at 8WAP. A significant correlation existed between the amount of organic matter by Colorimetric method and maize agronomic parameters. A linear relationship existed between the observed parameters, the R^2 ranged from 0.7586 to 0.9149. Among the agronomic parameters, plant height correlated best with Colorimetric OM. Furthermore, the regression equations are Colorimetric OM = 0.4424 (dry matter), Colorimetric OM = 20.885 (plant height) and Colorimetric OM = 0.8447 (stem girth). The order of relationship was recorded as Colorimetric OM and plant height > Colorimetric OM and stem girth > Colorimetric OM and dry matter.

Correlation between loss on ignition OM and maize agronomic parameters (dry matter, plant height, and stem girth) at 8WAP is presented in Figure 3. It was observed that a significant correlation existed between the amount of organic matter and maize agronomic parameters. A linear relationship existed between the observed parameters, and the R^2 ranged from 0.7388 to 0.8815. The order of relationship was recorded as loss on ignition OM, stem girth > loss on ignition OM, plant height > loss on ignition OM, and dry matter. Among the agronomic parameters, plant height correlated best with loss on Ignition OM. Furthermore, the regression equations are Loss on ignition OM = 0.4055 (dry matter), Loss on ignition OM = 18.976 (plant height), and Loss on ignition OM = 0.7693 (stem girth).

Figure 4 shows the correlation between Hydrogen peroxide OM and maize agronomic parameters (dry matter, plant height, and stem girth). The regression equations are Hydrogen peroxide OM = 0.0782 (dry matter), Hydrogen peroxide OM = 3.6799 (plant height), and Hydrogen peroxide OM = 0.147 (stem girth). It was observed that a significant correlation existed between the amount of organic matter and maize agronomic parameters. A linear relationship existed between the observed parameters, and the R^2 ranged from 0.7797 to 0.9401. The order of relationship was recorded as Hydrogen peroxide OM and plant height > Hydrogen peroxide OM and stem girth > Hydrogen peroxide OM and dry matter. Among the agronomic parameters, plant height correlated best with Hydrogen peroxide OM.

The correlation between Walkley Black OM and maize agronomic parameters (dry matter, plant height, and stem girth) is presented in Figure 5. The regression equations are Walkley Black OM = 0.4998 (dry matter), Walkley Black OM = 23.298 (plant height), and Walkley Black OM = 0.9448 (stem girth). It was observed that a significant correlation existed between the amount of organic matter and maize agronomic parameters. A linear relationship existed between the observed parameters, and the R^2 ranged from 0.8222 to 0.9717. The order of relationship was recorded as Walkley Black OM and plant height > Walkley Black OM and stem girth > Walkley Black OM and dry matter. Among the agronomic parameters, plant height correlated best with Walkley Black OM.

Among all the agronomic parameters correlated with soil organic matter methods, plant height was observed to correlate best with all the OM methods. However, among the organic matter methods, the Walkley-Black

OM correlated best with all the maize agronomic parameters. However, the order of relationship between organic matter methods and dry matter was WB > HP > > COL> LOI, a similar order was observed for plant height. However, a different order for the stem was observed as WB > COL > HP > LOI.

4.0. Conclusion

Organic matter determined was in the order of hydrogen peroxide > loss on ignition > colorimetric > Walkley black. Parent material affected the organic matter content. Plant height and stem girth of maize were location specific; however, the greatest effect was recorded in Odelemo (sedimentary parent material) for the first six weeks. A strong, significant relationship was observed among these methods as their R^2 ranged from 0.9028 to 0.9686, though the Colorimetric method and Loss on Ignition correlated best with each other. The regression equations are Walkley black = 0.9041 (colorimetric), Walkley black = 0.8187 (loss on ignition), colorimetric = 0.9141 (loss on ignition), Hydroxide peroxide = 5.0597 (loss on ignition), Walkley Black = 0.1555 (hydrogen peroxide), and Colorimetric = 0.1667 (hydrogen peroxide). Colorimetric method correlated very significantly with all agronomic parameters during the vegetative stage (2 – 6 weeks after planting),

Relationship between the organic matter method and maize agronomic parameters (8WAP) was also significant, with R^2 between 0.7586 and 0.9733. The order of relationship of OM methods with agronomic parameters was recorded as Walkley Black OM and plant height > Walkley Black OM and stem girth > Walkley Black OM and dry matter. The order of relationship was recorded as Hydrogen peroxide OM and plant height > Hydrogen peroxide OM and stem girth > Hydrogen peroxide OM and dry matter. The order of relationship was recorded as loss on ignition OM and stem girth > loss on ignition OM and plant height > loss on ignition OM, and dry matter. The order of relationship was recorded as Colorimetric OM and plant height > Colorimetric OM and stem girth > Colorimetric OM and dry matter. The correlation of organic matter methods with plant agronomic parameters differed with the phases of growth (vegetative phase and reproductive phase). Colorimetric OM correlated best with all the agronomic parameters before 8WAP (vegetative phase), whereas at 8WAP, agronomic parameters (reproductive phase) correlated with all the soil organic matter methods. Plant height at 8 weeks was observed to correlate best with all the OM methods. However, among the organic matter methods, Walkley-Black OM correlated best with all the maize agronomic parameters (8WAP). Furthermore, the Walkley-Black method of organic matter determination could be used as an index of uptake for soil organic matter in the reproductive phase of maize growth.

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Conflict of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1. Information on the different soils used for the experiment

Soils	Sample location	Parent material	State	Latitude	Longitude
BC Soil 1	Tonga roga	Basement complex	Kwara	8.763^0	4.998^0
BC Soil 2	Gidansule	Basement complex	Kwara	8.998^0	4.979^0
BC Soil 3	Ilorin	Basement complex	Kwara	8.372^0	4.372^0
BC Soil 4	Okeoyi	Basement complex	Kwara	8.559^0	4.559^0
BC Soil 5	Ogbomosho	Basement complex	Oyo	8.082^0	4.182^0
BC Soil 6	Oyo	Basement complex	Oyo	7.778^0	3.919^0
BC Soil 7	Ibadan	Basement complex	Oyo	7.386^0	3.725^0
BC Soil 8	Odeda	Basement complex	Ogun	7.228^0	3.495^0
BC Soil 9	Ayetoro	Basement complex	Ogun	7.229^0	3.402^0
SED Soil 1	Odogbolu	Sedimentary	Ogun	6.883^0	3.763^0
SED Soil 2	Odelemo	Sedimentary	Ogun	6.749^0	3.660^0
SED Soil 3	Epe	Sedimentary	Lagos	6.598^0	3.983^0
SED Soil 4	Ewekoro	Sedimentary	Ogun	6.523^0	3.123^0
SED Soil 5	Itori	Sedimentary	Ogun	6.925^0	3.210^0
SED Soil 6	Ilaro	Sedimentary	Ogun	6.967^0	3.033^0
SED Soil 7	Ijale orile	Sedimentary	Ogun	7.174^0	3.166^0
SED Soil 8	Ikenne	Sedimentary	Ogun	6.833^0	3.250^0
SED Soil 9	Ota	Sedimentary	Ogun	6.500^0	3.122^0

Table 2. Physico-Chemical characterization of soil samples

Soils	pH	Ca	Mg	K	Na	Al+H	ECEC	Tot.Org N	Tot. Org C	Org M	Av.P	Mn	Fe	Cu	Zn	Text.Class
		…………………cmol kg^{-1}………………..						…………%........................			……………..mgkg^{-1}……………					
BC Soil 9	6.08	3.75	1.59	0.49	1.01	0.07	6.91	0.16	1.44	2.48	36.13	11.78	10.25	0.76	3.51	Loamy sand
SED Soil 3	5.25	2.17	0.49	0.41	0.90	0.10	4.08	0.12	1.14	1.97	27.65	12.25	7.60	0.90	6.54	Sand
SED Soil 4	8.09	23.76	0.78	1.14	1.10	0.03	26.81	0.14	1.27	2.19	21.94	2.20	0.30	0.00	0.12	Loamy sand
BC Soil 7	7.80	3.77	0.50	0.44	0.86	0.04	5.62	0.08	0.67	1.16	31.44	53.60	13.55	0.91	4.18	Sand
SED Soil 7	6.58	3.86	1.37	0.32	0.84	0.05	6.44	0.15	1.36	2.34	26.58	47.90	7.45	0.71	1.88	Sand
SED Soil 8	6.75	5.18	0.88	0.55	0.93	0.08	7.62	0.13	1.17	2.01	19.89	30.95	3.65	0.62	7.53	Sand
SED Soil 6	7.16	4.94	0.93	0.97	0.99	0.04	7.87	0.18	1.49	2.57	22.08	39.85	4.75	1.10	6.47	Sand
BC Soil 3	6.98	2.98	0.51	0.27	0.86	0.04	4.66	0.10	0.80	1.38	30.91	72.15	5.70	0.35	7.55	Sand
SED Soil 5	6.61	5.43	0.59	0.19	0.82	0.05	7.08	0.09	0.75	1.29	37.37	21.35	7.60	0.22	2.60	Sand
BC Soil 8	6.74	4.76	1.12	0.24	0.90	0.05	7.08	0.17	1.65	2.84	32.96	52.65	4.95	0.16	13.36	Sand
SED Soil 1	4.77	4.17	0.88	0.35	0.78	0.12	6.30	0.12	1.19	2.05	36.93	12.10	28.65	0.38	105.8	Loamy Sand
SED Soil 2	7.69	9.38	1.65	0.38	0.50	0.05	11.96	0.19	2.03	3.50	29.79	83.90	9.00	1.02	73.48	Sand
BC Soil 5	6.82	3.60	0.97	0.29	1.63	0.06	6.55	0.10	0.94	1.62	38.27	44.85	12.20	0.46	10.39	Sand
BC Soil 4	6.54	2.84	0.75	0.25	0.95	0.05	4.84	0.09	0.84	1.45	34.52	32.25	6.35	0.29	3.16	Sand
SED Soil 9	4.82	1.19	0.46	0.27	1.01	0.11	3.04	0.06	0.63	1.08	34.48	21.55	9.70	0.87	3.42	Loamy Sand
BC Soil 6	7.87	4.15	0.58	0.24	0.93	0.04	5.93	0.05	0.65	1.12	33.72	36.80	6.70	0.29	3.70	Sand
BC Soil 1	7.13	4.40	0.66	0.55	0.90	0.05	6.56	0.11	1.11	1.91	38.76	61.75	10.25	0.22	1.40	Sand
BS Soil 2	8.06	12.73	0.99	0.68	0.95	0.03	15.38	0.22	2.14	3.69	28.99	70.60	5.30	0.28	2.53	Sand

Table 3. Organic matter determination methods as affected by Location

Location	Walkley Black	Colorimetric	Hydrogen peroxide	Loss on ignition
BC Soil 8	2.67a	2.59bc	11.58fgh	2.94b-e
SED Soil 7	2.61ab	2.68bc	12.49d-g	3.22a-d
BC Soil 3	2.51bc	2.39bcd	11.28fgh	1.35hi
SED Soil 8	2.44cd	2.34b-e	20.00a	2.07e-h
SED Soil 2	2.39cd	3.69a	16.44b	3.59a
SED Soil 4	2.38cd	2.78b	12.99def	3.33abc
SED Soil 6	2.38cd	2.66bc	11.78e-h	3.11a-d
BC Soil 2	2.29de	3.49a	14.82bcd	3.88a
SED Soil 3	2.28de	2.29b-e	12.78def	2.39d-g
BC Soil 9	2.18ef	2.21cde	12.22e-h	2.77b-f
BC Soil 5	2.12fg	1.89efg	12.21e-h	2.04fgh
SED Soil 5	2.11fg	2.47bcd	11.67e-h	2.56c-g
BC Soil 1	2.10fgh	2.08def	14.11cde	2.02fgh
BC Soil 6	1.99gh	1.46g	11.88e-h	1.01i
BC Soil 4	1.96gh	1.67fg	15.56bc	2.02fgh
SED Soil 9	1.92h	1.64fg	10.00h	1.69ghi
SED Soil 1	1.89h	2.37b-e	21.82a	3.37abc
BC Soil 7	1.72i	1.62fg	10.07gh	1.07i

Table 4. Effect of soil types on plant height of maize

Soils	2 WAP	4WAP	6WAP	8WAP
	…………………………………………	..(cm)……	……………………………	………………………
SED Soil 2	26.1a	49.50a	60.00a	61.50a
SED Soil 8	23.0ab	41.30c	44.50d	45.00ef
BC Soil 8	20.30abc	39.33cd	47.57bcd	56.60bcd
SED Soil 6	20.07abc	40.03cd	45.67bcd	52.47cde
SED Soil 3	19.07bcd	40.33cd	45.70cd	49.23de
SED Soil 5	19.03bcd	40.70c	43.93d	45.80ef
SED Soil 4	18.60bcd	42.70bc	44.00d	51.2de
BC Soil 9	18.50bcd	33.90de	42.67d	48.07de
BC Soil 6	17.83bcd	39.60cd	49.10bcd	56.47bcd
BC Soil 2	17.47bcd	42.23bc	52.4bc	60.33bc
BC Soil 5	17.47bcd	48.20ab	54.00ab	61.10abc
SED Soil 7	17.07bcd	37.07cd	43.13d	51.17de
SED Soil 1	17.03bcd	41.70c	59.3a	68.8a
BC Soil 3	16.30bcd	40.40cd	45.03d	50.37de
BC Soil 1	16.20bcd	37.83cd	47.57bcd	53.27b-e
SED Soil 9	14.87cd	29.60ef	33.53e	38.47fg
BC Soil 7	14.17cd	40.27cd	49.23bcd	53.53b-e
BC Soil 4	12.73d	24.47f	29.80e	33.53g

Means with same letter along the column are not significantly different at $p<0.05$

WAP – Weeks after planting

Table 5. Effect of soil types on stem girth of maize

Soils	2WAP	4WAP	6WAP	8WAP
	………………………………………………	…(cm)…	………………………………………………	
SED Soil 2	1.30a	1.80a	2.60a	3.50a
SED Soil 8	1.10a-e	1.80ab	2.00bc	2.10cde
BC Soil 8	1.00cde	1.60b-e	1.77cde	2.20bc
SED Soil 6	1.27ab	1.50d-g	1.90b-e	2.10cde
SED Soil 3	1.23ab	1.47efg	1.70d-g	1.83ef
SED Soil 5	1.00cde	1.20i	1.70d-g	1.73fg
SED Soil 4	1.20abc	1.50d-g	2.00bcd	2.40b
BC Soil 9	1.10a-e	1.43e-h	1.80cde	1.90def
BC Soil 6	0.90e	1.73abc	1.87b-e	2.17bcd
BC Soil 2	1.13a-d	1.87a	2.13b	2.33bc
BC Soil 5	1.13a-d	1.70a-d	2.07bc	2.13bcd
SED Soil 7	1.13a-d	1.37f-i	1.63efg	1.80fg
SED Soil 1	1.00cde	1.33ghi	2.00bcd	2.33bc
BC Soil 3	0.93de	1.23hi	1.73def	2.17bcd
BC Soil 1	1.00cde	1.57c-f	1.87b-e	1.70fg
SED Soil 9	0.90e	0.97j	1.43g	1.53g
BC Soil 7	1.07b-e	1.47efg	1.97bcd	2.20bc
BC Soil 4	0.90e	1.00j	1.47fg	1.63fg

Means with same letter along the column are not significantly different at p<0.05

WAP – Weeks after planting

Table 6. Effect of different soils on the dry matter yield (g) of Maize

SED Soil 2	SED Soil 8	BC Soil 8	SED Soil 6	SED Soil 3	SED Soil 5	SED Soil 4	BC Soil 9	BC Soil 6	BC Soil 2	BC Soil 5	SED Soil 7	SED Soil 1	BC Soil 3	BC Soil 1	SED Soil 9	BC Soil 7	BC Soil 4
2.20a	0.84h	0.90gh	1.26d	0.97fg	0.66i	1.07ef	0.95gh	1.16de	1.61c	2.20a	0.53j	1.75b	1.27d	0.64i	0.23k	1.13e	0.46j

Means with same letter along the row are not significantly different at p<0.05

Table 7. Correlation between Soil organic matter methods and maize agronomic parameters

	Plant height			Stem girth		
	2WAP	4WAP	6WAP	2WAP	4WAP	6WAP
Walkley Black	0.391**	0.251NS	0.054NS	0.332*	0.277*	0.124NS
Colorimetric	0.398**	0.472***	0.427**	0.496***	0.385*	0.524***
Hydrogen peroxide	0.159NS	0.121NS	0.303*	0.068NS	0.229NS	0.322*
Loss on ignition	0.316*	0.203NS	0.327*	0.476***	0.214NS	0.329*

Means with same letter along the column are not significantly different at $p<0.05$

WAP – Weeks after planting

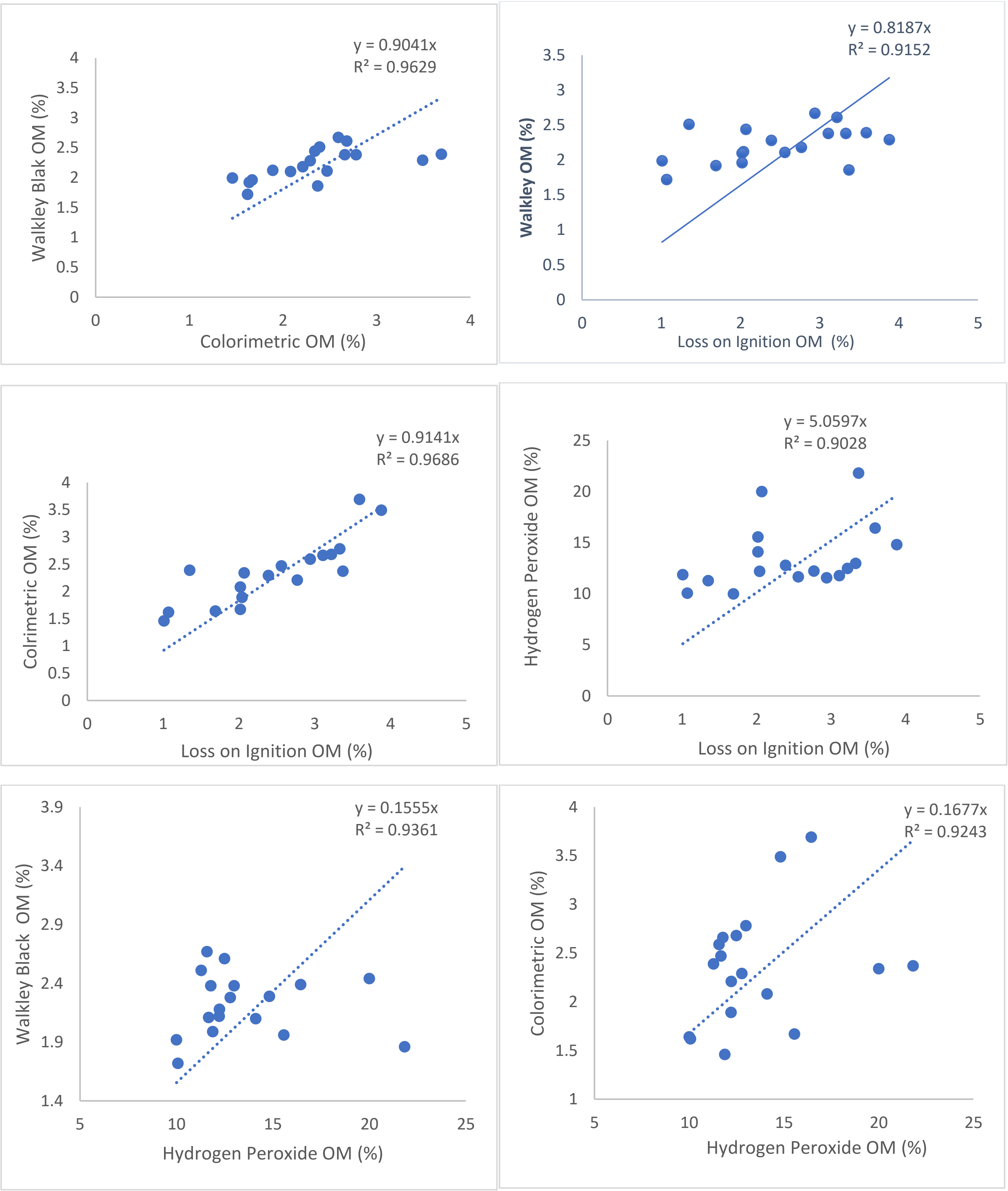
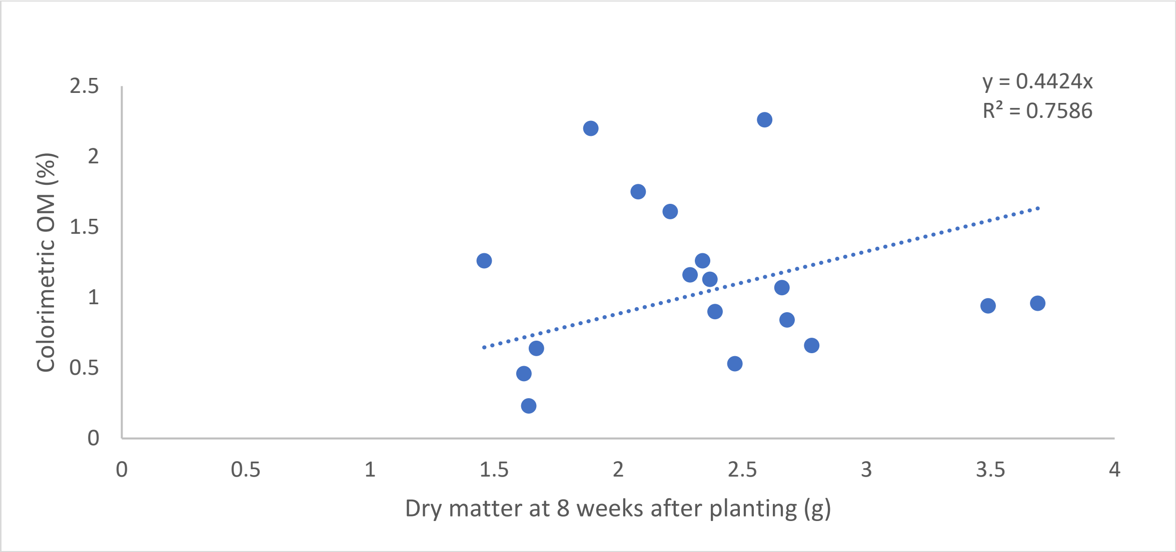
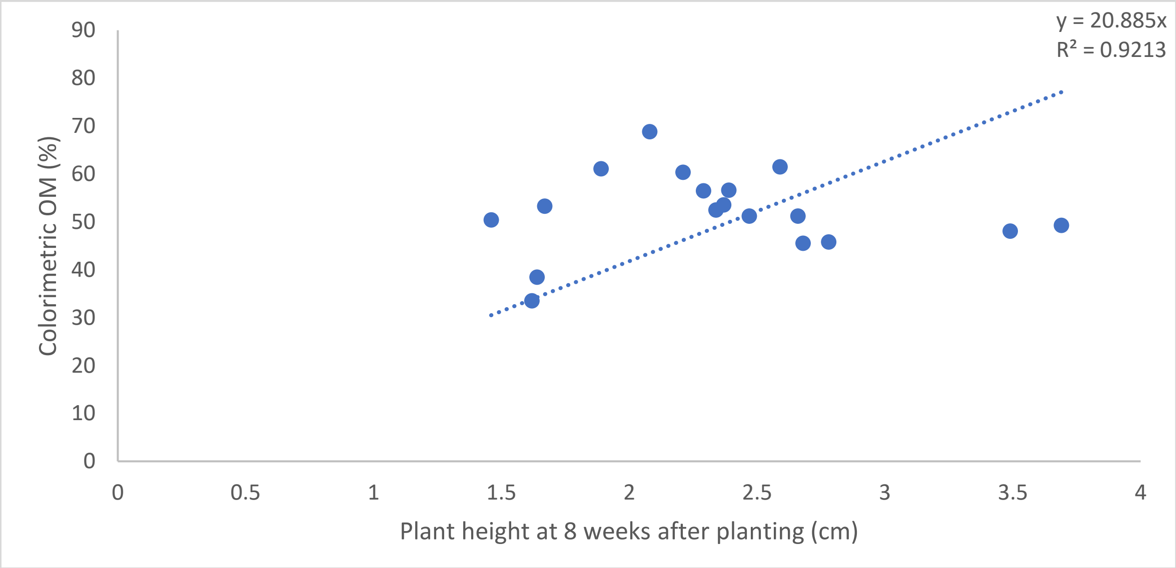


Figure 1. Relationship between organic matter determination methods


y = 0.4424x
R² = 0.7586
Colorimetric OM (%)
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
4
Dry matter at 8 weeks after planting (g)


y = 20.885x
R² = 0.9213
Colorimetric OM (%)
90
80
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
3.5
4
Plant height at 8 weeks after planting (cm)

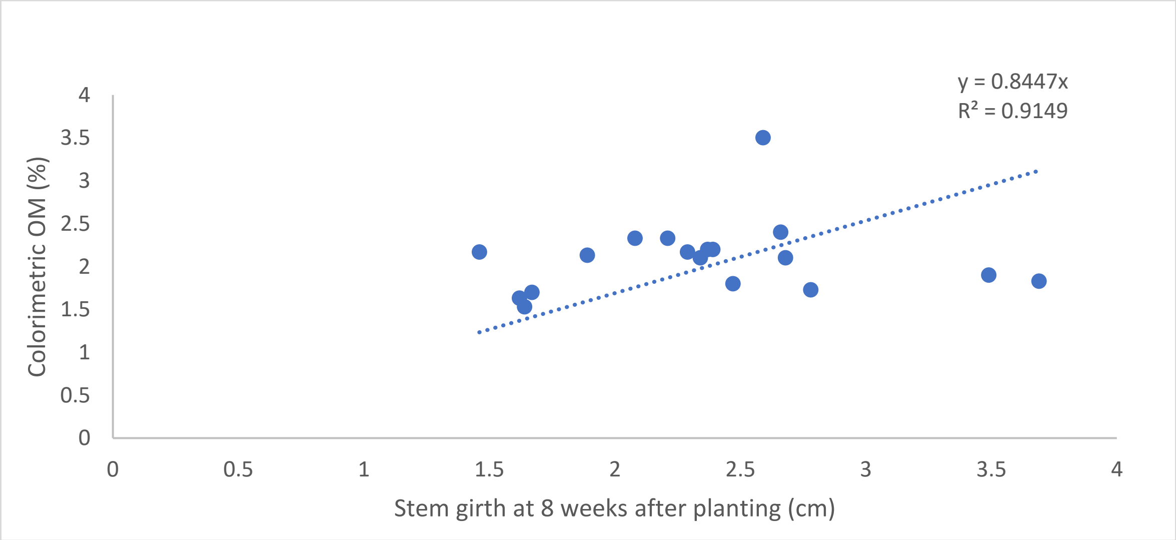

y = 0.8447x
R² = 0.9149
Colorimetric OM (%)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
4
Stem girth at 8 weeks after planting (cm)

Figure 2. Relationship between Colorimetric OM and maize agronomic parameters

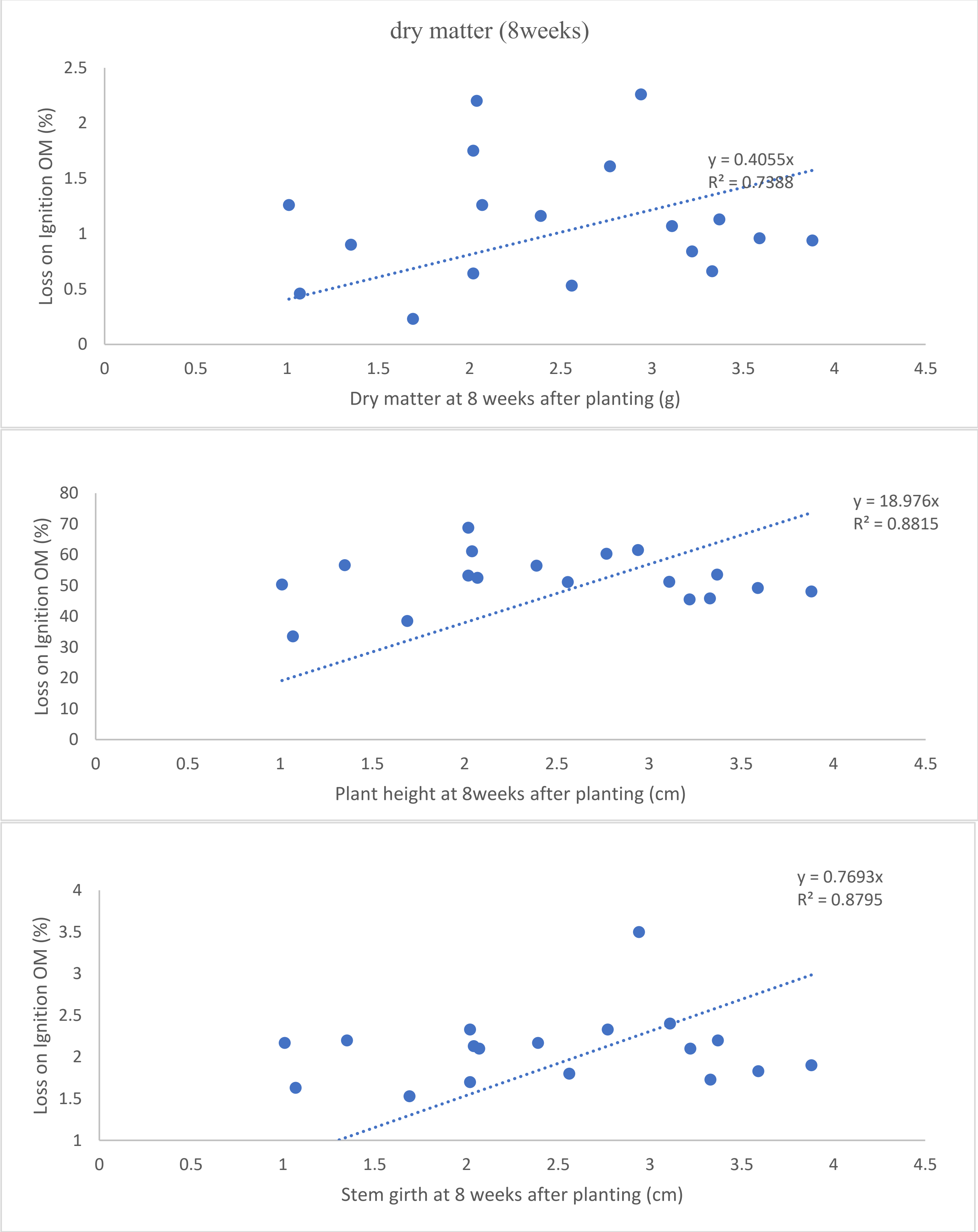
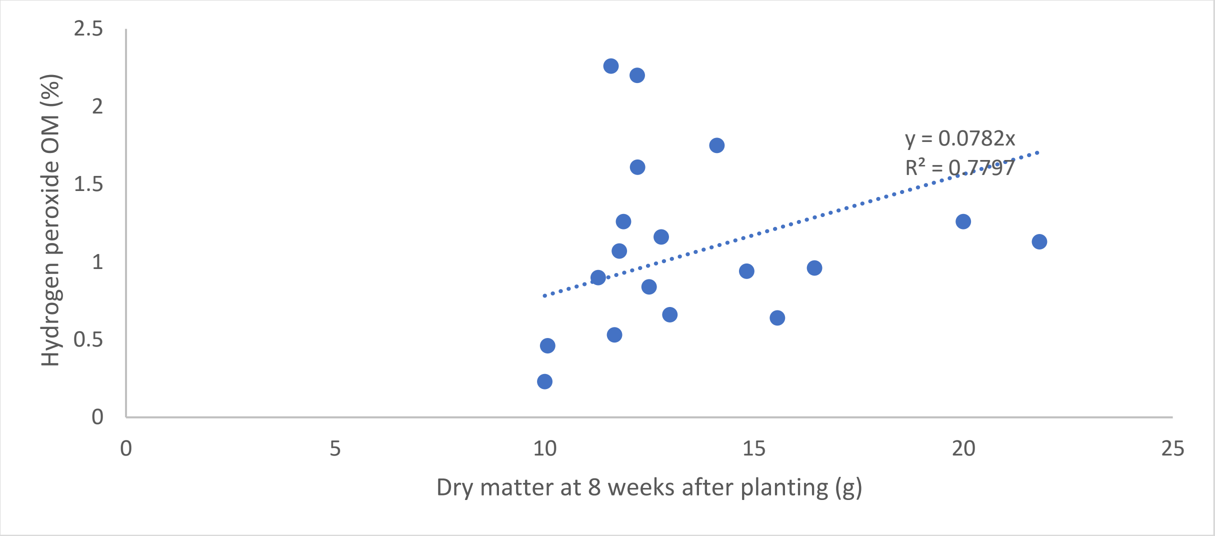
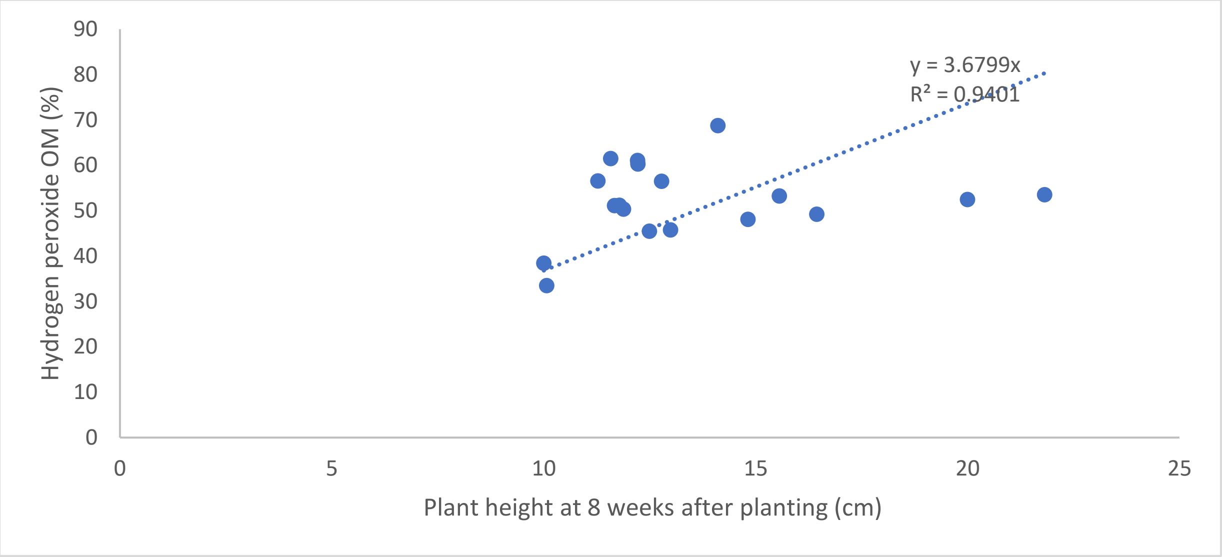


Figure 3. Relationship between Loss on Ignition OM and maize agronomic parameters


Hydrogen peroxide OM (%)
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Dry matter at 8 weeks after planting (g)
y = 0.0782x
R² = 0.7797


Hydrogen peroxide OM (%)
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
Plant height at 8 weeks after planting (cm)
y = 3.6799x
R² = 0.9401

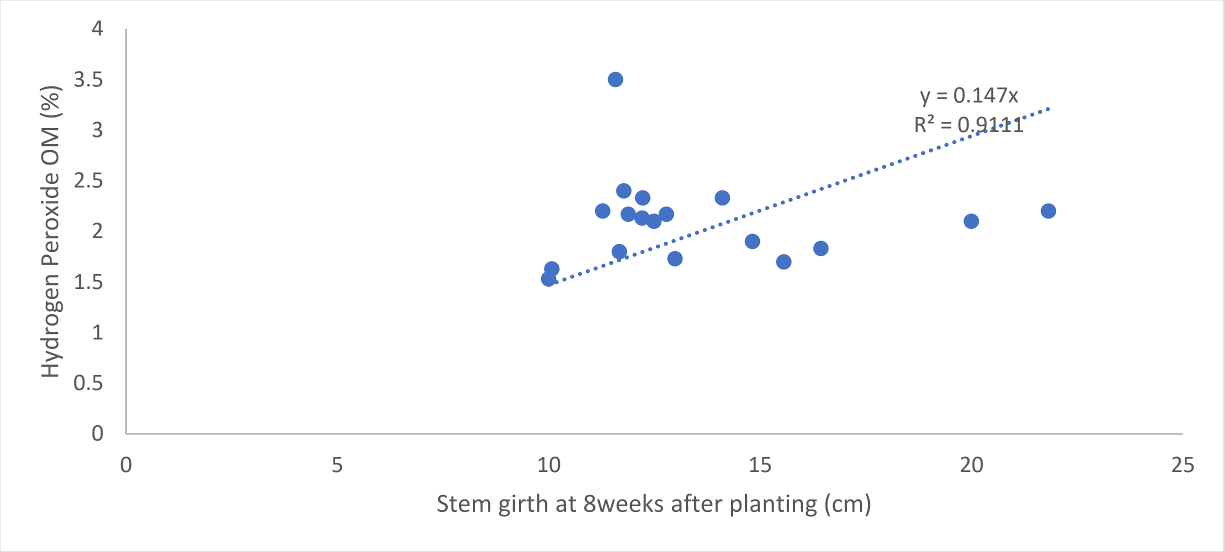
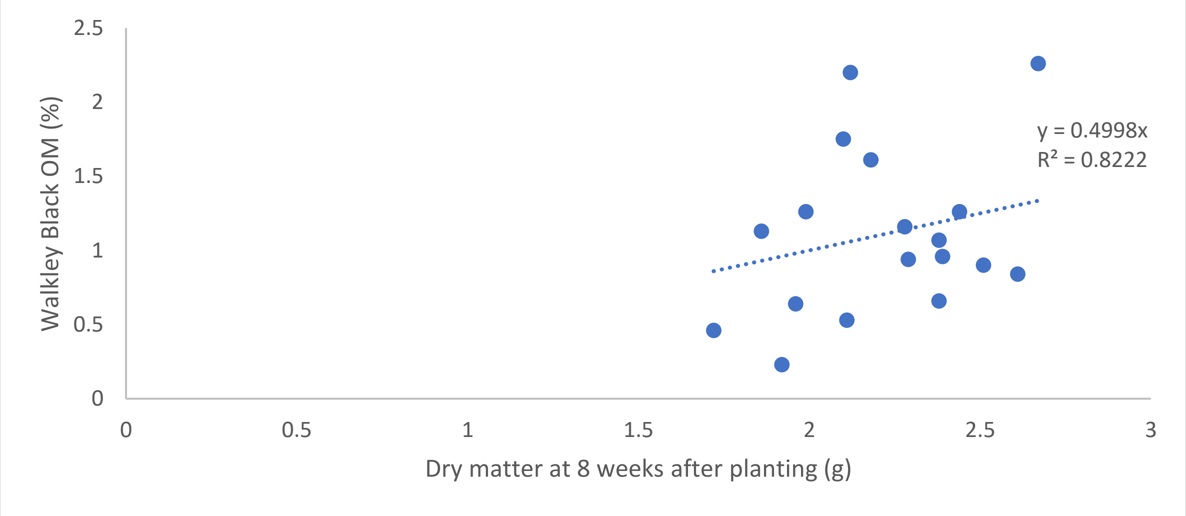
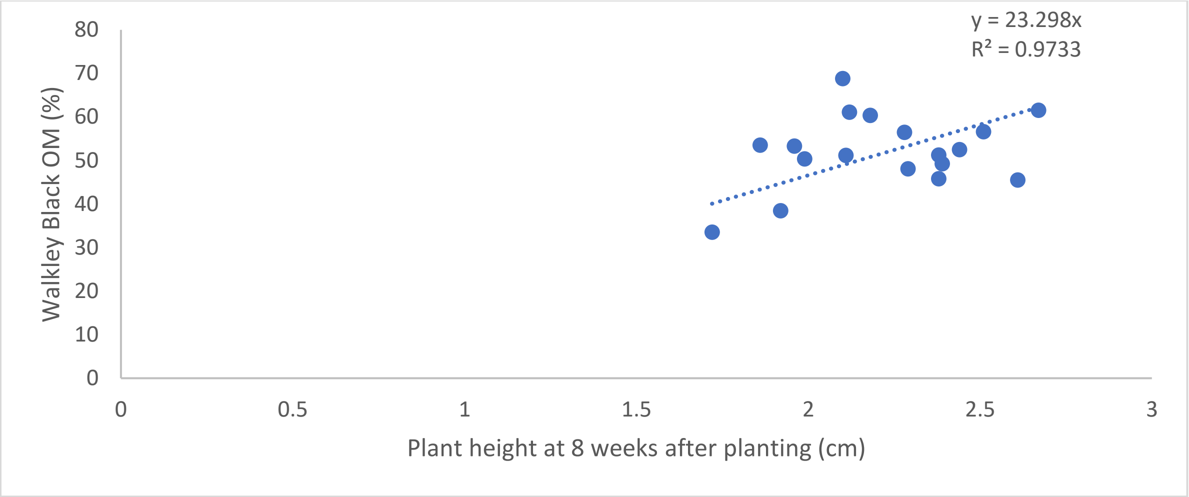


Figure 4. Relationship between Hydrogen Peroxide OM and maize agronomic parameters





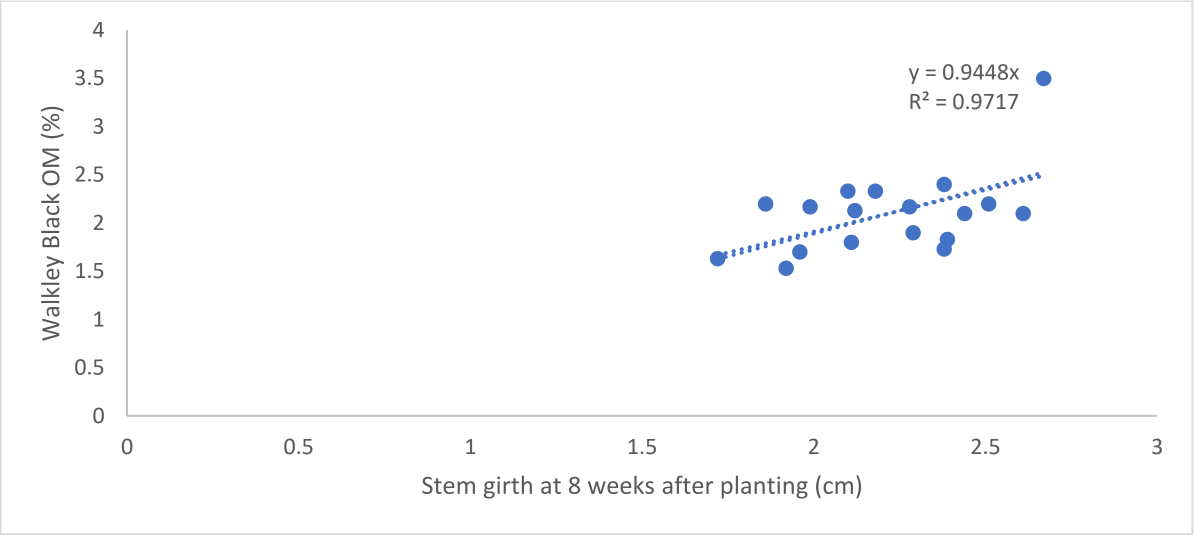


Figure 5. Relationship between Walkley Black OM and maize agronomic parameters