Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, Egypt
28(4), 1295-1316, 2020
Website: http://ajs.journals.ekb.eg

Significance of Some Natural Amendments to Improve Soil Properties and Plant Growth

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Received 24 September, 2020 Accepted 25 October, 2020

Abstract

Many problems facing sandy, calcareous and heavy clay soils and restricts plant growth, nutrients availability and sustainable agriculture. Soil amendments are considered to be the most realistic soil management methods to improve soil chemical and physical properties. Improving some soil physical and chemical properties, study the correlation between soil properties and their effect on plant growth and nutrients uptake by faba bean plant (*Vicia faba L. var.*716) were the main purpose of this study. To achieve this purpose three factorial pot experiments were conducted by addition rates (0, 5 and10 ton. fed^{-1}) of farmyard manure (FYM), phosphate rock (PhR) and rice straw (RS) either alone or mixed to sandy, calcareous sandy loam and clay soils. Soils were incubated with the studied treatments for 15 days before planting. The main results showed that the addition rates of soil amendments led to slightly increase in soil salinity, total porosity and significant increase in organic matter content in the experimental soils. Bulk density and pH decreased with increased the rates of FYM and PhR either alone or mixed with RS. Decreasing in hydraulic conductivity in sandy and sandy loam soils, while it increases in clay soil. Generally, there are negative correlations between soil organic matter and both of hydraulic conductivity and bulk density in sandy and sandy loam soils, while, organic matter and hydraulic conductivity gave a positive effect in clay soil. Changes in soil properties had a positive effect of faba bean growth and macro nutrients uptake. The highest rates of the studied materials showed a significant increase in fresh and dry weight, NPK content and uptake of faba bean plant. Integrated use of the highest rates of FYM and PhR with RS were the best option for sustaining physical and chemical properties, enhancing faba bean growth and nutrients uptake of the studied soils.

Keywords: Soil properties, Natural amendments, Nutrients, Faba bean

1 Introduction

Understanding the relationship between different soil properties and agricultural practices is essential for sustainable land use. In fact, organic matter content and water movement are significant components and key indicators of soil quality. Moreover, nutrients uptake and plant growth depend on the complex interactions of soil properties and the processes that take place in them and its directly related to different physical soil properties (Shi et al 2017). Sandy soils are characterized by poor physical properties such as high evaporation, high permeability and excessive drainage of rain and irrigation water below the root zone, which leading to low water-holding capacity (Andry et al 2009). Many challenges are encountered during cultivation of calcareous soils, such as low water retention, poor structure, low organic matter, nutrients loss via leaching or deep percolation. Also, high $CaCO_3$ content caused many problems such as, surface crusting, high pH and low nitrogen use efficiency, low availability of macronutrients and micronutrients (El-Hady and Abo-Sedera 2006). The suitability extent of calcareous soils for agriculture depends on management systems via adding of organic materials and some amendments to improve availability of nutrients, particularly phosphorus and hydraulic conductivity (Karimi et al 2012). Determination of hydraulic conductivity is needed ensuring the satisfactory land use (Mortezaei and Karimpour-Fard 2017). The soil characteristics such as, texture, pore size distribution, bulk density, organic matter content, and exchangeable cations substantially influence the soil hydraulic properties (Bardhan et al 2016). Improving of hydraulic properties had appositive relationships with plant available nutrients, nutrient uptake and yields of both maize and wheat crops. (Thangasamy et al 2017). The hydraulic conductivity is not an exclusive property of the soil alone, it depends upon the soil properties and the fluid together (Chaudhari et al 2010). All plants required good drainage in their planting area. Adding organic materials will help give clay soil better drainage and will also provide nutrients. Mouhamad et al (2015) suggested that the application of organic matter to any type of soil which will be improve soil properties for sustainable cropping system.

Application of organic materials improve soil chemical and physical properties, nutrient availability, especially as combined with chemical fertilizer management (Yunchen et al 2009), can help to stabilize soil structure and decrease soil bulk density, improvement of hydraulic conductivity and providing an environment that will allow for the growth of healthy root systems (Curtis and Claassen, 2009). The integrated use of organic manure and recommended dose of mineral fertilizers providing a significant improvement in crop yields and quality especially in the poor soils (El Sheikha 2016). Generally, organic materials application has important dynamic effects on chemical fractions of some nutrients released from manure which gradually converted into available forms by the time (Halajnia et al 2009), an important management strategy that can improve soil characteristics (Oliveira et al 2014). Phosphate rock is relatively slow in releasing soluble P, low price in comparison with mineral P fertilizers and can be applied as a source of P, but its effectiveness depends on its reactivity in the soil especially calcareous soils (Hellal et al 2019). Rice straw is unique relative to other crops straws in being low in lignin and high in nitrogen, potassium and silica. Addition of rice straw improved soil properties of heavy clay soil than other organic manure (Nyalemegbe et al 2009). Addition of soil amendments can increase soil organic matter, water holding capacity, soil porosity, water infiltration and percolation and decreasing bulk density and subsequently improving in plant growth (Li et al 2018).

Naturally, fine-textured soils are characterized by high total porosity and low macro pores. On the opposite, coarse-texture soils have low total porosity and high macro pores. The relationship between some soil properties like hydraulic conductivity, organic matter and clay content and its effect on plant growth and nutrient uptake are very important. So, the addition of natural amendments can improve soil physical and chemical properties, plant growth and supplying nutrients. Therefore, the objective of the current work is to study the changes of physical and chemical properties in sandy, calcareous sandy loam and clay soils due to addition of different application rates of phosphate rock, farmyard manure and rice straw, and their effect on faba bean growth and nutrients uptake.

2 Materials and Methods

Surface samples were collected from sandy, sandy loam (calcareous), and clay soils and treated with the studied materials for achieving the aim of the experiment.

2.1 Experimental design

Three factorial of pots experiment were conducted with three replicates at the farm of Faculty of Agriculture, Al- Azhar University, Nasr city, Cairo, Egypt during the winter season of 2018. The treatments were added in each soil as alone or mixture as follows: control (recommended dose of mineral fertilizers), 5 and 10 ton.fed^{-1} of phosphate rock (Ph R), 5 and 10 ton.fed^{-1} of farmyard manure (FYM), 5 and 10 ton.fed^{-1} of rice straw (RS) as alone; and 5 ton.fed^{-1} FYM+5 ton. fed^{-1} RS, 5 ton. fed^{-1} FYM+10 ton. fed^{-1} RS, 10 ton.fed^{-1} FYM+5 ton. fed^{-1} RS, 10 ton. fed^{-1} FYM+10 ton. fed^{-1} RS, 5 ton. fed^{-1} Ph R+5 ton.fed^{-1} RS, 5 ton. fed^{-1} Ph R +10 ton. fed^{-1} RS, 10 ton. fed^{-1} Ph R +5 ton. fed^{-1} RS and 10 ton. fed^{-1} Ph R +10 ton. fed^{-1} RS, as a mixture.

The investigated soils were mixed with FYM, PhR and RS after their crushing and sieving through a 2-mm sieve. Plastic pots (30×22.5 cm) were filled with 10 kg of amended soils. Pots were incubated for 15 days before planting; moisture content was kept at 60% of field capacity during the incubation period. Eight seeds were cultivated in every pot and thinned to 4 plants of faba bean (*Vicia faba L. var.*716) after 10 days. Moisture content of pots was kept approximately at field capacity with tap water during the experimental period (60 days). Mineral fertilizers were applied as the recommended dose, ammonium sulphate (20.5 % N) applied at a rate of 20 kg Nfed^{-1} for newly soils and 15 kg N fed^{-1} for clay soil. Calcium superphosphate (15 % P_2O_5) was applied during soil preparation at rate of 150 kg for newly soils and 100 kg P_2O_5 fed^{-1} for clay soils. While, potassium sulfates (48.5 % K_2O) added after 35 days of planting applied at rate of 50 kg K_2O fed^{-1}.

2.2 Plant sampling

After 60 days from planting, faba bean shoots of each pot were cut just one cm above the soil surface and prepared for analysis. The shoots were oven dried at 70°C to a constant weight, then dry weights were recorded. The dried plant tissues were ground using a mill and kept for plant analysis. 0.5 g of the dry matter of each sample was digested by using a mixture of concentrated perchloric and sulphuric acid (1: 3) according to Chapman and Pratt (1961). Then, the plant digests were diluted with distilled water to a volume of 50 mL. Total N was determined by micro-Kjeldahl technique, total P was determined by ascorbic acid method and total K was determined using flame photometer according to Cottenie et al (1982).

2.3 Soil sampling

Soil samples from each pot were taken after harvesting, air- dried, crushed and passed through a 2 mm sieve and kept for soil analysis. The characteristics of the investigated soils, i.e. particle size distribution, particle density, bulk density, total porosity, hydraulic conductivity, soil pH, EC, soluble cations and anions, OM, CEC, $CaCO_3$ available N, P, K were determined (Page et al 1982, Klute 1986). Soil porosity calculated from equation, $porosity = 1 - \frac{BD}{PD} \times 100$, where, BD = bulk density and PD = particle density *(*Blake and Hartage 1986*).* Hydraulic conductivity determined at saturated case in the laboratory using the constant-head method through the equation $K(cmh^{-1}) = \frac{QL}{HAT}$, where Q= Volume of water passed through the column in cubic centimeter (cm^3), L= Length of the soil core in cm, H=Total height of the water column in cm, A = Cross-sectional area of the inner side of the tube in cm^2, T= Time of flow in hour (Klute 1986). Macro and micronutrients of the studied materials, according to Cottenie et al (1982). The obtained data of soils chemical and physical properties are presented in **Table 1**. Also, chemical composition of phosphate rock, farmyard manure and Rice straw are presented in **Table 2.**

2.4 Statistical analysis

The data obtained were statistically analyzed according to Snedecor and Cochran (1989). Significantly different was calculated at a 5% level of probability.

Table 1. Some physical and chemical properties of the investigated soils

Soil parameter	Sandy soil	Sandy loam soil	Clay soil
	value	value	value
Particle size distribution %			
Sand	90.0	71.50	16.50
Silt	7.50	16.70	24.40
Clay	2.50	11.80	59.10
Texture class	Sandy	Sandy loam	Clay
Bulk density $Mg.m^{-3}$	1.73	1.60	1.38
F.C %	9.80	22.50	37.80
W. P %	2.70	4.70	15.60
A.W %	7.10	17.80	22.20
Hydraulic conductivity $cm.h^{-1}$	25.50	8.40	1.80
Chemical properties			
pH (1:2.5 soil suspension)	7.50	8.75	7.87
EC $dS.m^{-1}$(1:2.5 soil extract)	1.78	2.35	2.56
OM %	0.32	0.65	2.20
CEC $cmol_c\ kg^{-1}$	3.00	6.80	53.6
$CaCO_3$ %	2.25	18.00	4.50
Soluble ions $mmol_c l^{-1}$			
Ca^{++}	3.80	7.40	6.60
Mg^{++}	2.90	3.50	4.60
Na^{+}	9.00	6.50	10.90
K^{+}	0.70	2.80	1.20
$CO_3^{=}$	0.00	0.00	0.00
HCO_3^{-}	6.30	4.40	6.60
Cl^{-}	7.50	9.40	11.50
$SO_4^{=}$	2.60	6.40	5.20
Available macro nutrients $mg.kg^{-1}$			
N	44.50	58.40	87.50
P	8.50	7.20	14.20
K	68.00	120.0	240.0

Table 2. Chemical composition of the used materials.

<table>
<tr><th colspan="13">Farmyard manure *</th></tr>
<tr><th rowspan="2">Parameter</th><th rowspan="2">pH (1:2.5 suspension)</th><th rowspan="2">EC dSm^{-1} (1:2.5)</th><th rowspan="2">OM %</th><th rowspan="2">OC %</th><th rowspan="2">C/N ratio</th><th colspan="3">Total macronutrients (%)</th><th colspan="4">Total micronutrients (mg.kg^{-1})</th></tr>
<tr><th>N</th><th>P</th><th>K</th><th>Fe</th><th>Zn</th><th>Cu</th><th>Mn</th></tr>
<tr><td>Value</td><td>6.90</td><td>3.45</td><td>35.95</td><td>20.9</td><td>11.48</td><td>1.82</td><td>1.35</td><td>1.65</td><td>1650</td><td>85.0</td><td>15.5</td><td>120</td></tr>
<tr><td colspan="13">Phosphate rock**</td></tr>
<tr><td>Parameter</td><td colspan="2">pH (1:5 suspension)</td><td colspan="2">EC dSm^{-1} (1:5)</td><td>P_2O_5 %</td><td colspan="2">Ca O %</td><td>SiO_2 %</td><td>Fe_2O_3 %</td><td>Al_2O_3 %</td><td>MgO %</td><td>K_2O %</td></tr>
<tr><td>Value</td><td colspan="2">6.67</td><td colspan="2">1.55</td><td>25.00</td><td colspan="2">41.00</td><td>6.90</td><td>4.20</td><td>0.80</td><td>2.00</td><td>0.20</td></tr>
<tr><td colspan="13">Rice straw***</td></tr>
<tr><td>Parameter</td><td colspan="2">pH (1:10 suspension)</td><td colspan="2">EC dSm^{-1} (1:10)</td><td>OM %</td><td>OC %</td><td>C/N ratio</td><td>N %</td><td>P %</td><td>K %</td><td>Ca %</td><td>Mg %</td></tr>
<tr><td>Value</td><td colspan="2">6.11</td><td colspan="2">2.40</td><td>58.48</td><td>34.0</td><td>45.33</td><td>0.75</td><td>0.21</td><td>1.35</td><td>0.14</td><td>0.10</td></tr>
</table>

* Farm yard manure is a decomposed mixture of Cattle dung and urine with straw which used as bedding material and residues from the fodder fed to the cattle from farm of Faculty of Agriculture, Al-Azhar University, Cairo.

**Phosphate rock from Abu- Zaabal Company for Fertilizers and Chemical Industries, Al- Qalyubia Governorate, Egypt.

***Rice straw was collected from local farms from Al- Sharqia Governorate Egypt.

3 Results and Discussion

3.1 Soil chemical properties

Soil chemical properties as affected by phosphate rock (Ph R), farmyard manure (FYM) and rice straw (RS) are presented in **Table 3**. Soil pH decreased with increasing the addition rates of the studied materials. The pH values ranged between7.44 to 7.30, 8.70 to 7.36 and 7.81 to 7.54 in sandy, sandy loam and clay soils, respectively. The lowest values were observed at10 ton.fed^{-1} FYM + 10 ton. fed^{-1} RS, as compared to control which recorded the highest values. This may be due to the release of organic acids from applied organic materials. These data have been reported by Barka et al (2018). Also, Kabirinejad et al (2014) attribute the decrement in soil pH to increase of the processes of organic matter decomposition and nitrification processes, and oxidation of organic compounds in the soil.

On the other hand, the highest values of EC were observed by the highest rates of PhR or FYM alone, while the lowest values were observed at the highest rate of RS. It may be due to decomposition of organic amendments with increasing their effects on dissolving salts in soil and increase the soluble ions in soil solution (Mekki et al 2006). However, in all treatments, EC values remained below the salinity threshold (4 dS m^{-1}). These findings were consistent with Chartzoulakis et al (2010) who reported that EC values increased during the applying different organic amendments.

Also, the application of the studied amendments led to change in organic matter content. Significant increase in organic matter content with application of FYM and RS. The values reached at 0.58, 1.35 and 2.53 %, in sandy, sandy loam and clay soils, respectively. Addition of organic amendments can improve the chemical and physical properties of soil, which led to increase soil organic matter content and nutrients release (Youssef et al 2001). On the other hand, a slightly decrease of $CaCO_3$ content was observed at the sandy loam (calcareous soil) treated with rice straw.

3.2 Soil physical properties

Hydraulic conductivity and soil porosity are essential soil physical properties which determines the ability of the soil to transmit water and air through its pore spaces and largely controls the soil, plant and water relations and processes. The data presented in **Table 4** showed that the hydraulic conductivity (HC), bulk density (BD), and total porosity (TP) were improved by the addition rates of phosphate rock (Ph R), farmyard manure (FYM) and rice straw (RS). The changes were observed at all the studied soils (sandy, sandy loam and clay soils). In general, sandy soil has been affected more than sandy loam and clay soils. The values were ranged between

Table 3. Some soil chemical properties as affected by the studied materials

Treatments (ton. fed^{-1})		Sandy soil			Sandy loam soil (calcareous)				Clay soil		
		pH	EC dS.m^{-1}	OM %	pH	EC dS.m^{-1}	OM %	$CaCO_3$ %	pH	EC dS.m^{-1}	OM %
Control		**7.44**	**1.84**	**0.38**	**8.70**	**2.42**	**0.70**	**18.50**	**7.81**	**2.64**	**2.32**
Farmyard manure (FYM)	5	7.37	1.88	0.44	8.50	2.50	0.83	16.60	7.70	2.70	2.40
	10	7.32	1.98	0.54	8.57	2.60	1.30	15.20	7.66	2.77	2.50
Phosphate Rock (Ph R)	5	7.40	1.90	0.33	8.70	2.54	0.70	19.00	7.80	2.69	2.30
	10	7.40	1.95	0.30	8.73	2.59	0.65	19.50	7.83	2.81	2.20
Rice Straw (RS)	5	7.40	1.75	0.35	8.68	2.30	0.73	17.00	7.80	2.55	2.25
	10	7.35	1.70	0.40	8.60	2.25	0.80	16.20	7.75	2.60	2.20
5 FYM + 5 RS		7.34	1.87	0.47	7.46	2.47	1.20	16.50	7.67	2.67	2.40
5 FYM + 10 RS		7.31	1.85	0.50	7.40	2.44	1.25	15.40	7.60	2.70	2.44
10 FYM + 5 RS		7.30	1.80	0.50	7.41	2.55	1.27	15.00	7.60	2.76	2.45
10 FYM + 10 RS		7.30	1.85	0.58	7.36	2.58	1.35	14.50	7.54	2.70	2.53
5 Ph R + 5 RS		7.42	1.80	0.35	7.65	2.53	0.75	17.00	7.78	2.66	2.24
5 Ph R + 10 RS		7.40	1.75	0.40	7.60	2.50	0.80	16.50	7.55	2.70	2.30
10 Ph R + 5 RS		7.40	1.90	0.32	7.63	2.57	0.77	18.00	7.74	2.75	2.20
10 Ph R + 10 RS		7.36	1.88	0.38	7.60	2.60	0.88	17.00	7.70	2.75	2.30
LSD	FYM (A)	0.20	0.25	0.14	0.67	0.27	0.25	1.45	0.30	0.30	0.33
	Ph R (B)	0.30	0.18	0.15	1.70	0.30	0.74	2.70	0.18	0.26	0.33
	RS (C)	0.27	0.14	0.13	1.57	0.24	0.13	2.34	0.84	0.14	0.21
	AC	0.22	0.37	0.15	0.49	0.19	0.31	2.70	0.31	0.23	0.26
	BC	0.20	0.34	0.14	1.54	0.48	0.23	3.38	0.24	0.20	0.25

25.50 cm.h^{-1} to 19.00 cm.h^{-1} and 8.57 cm.h^{-1} to 5.85 cm.h^{-1} in sandy and sandy loam soils, respectively. It can be noticed that the lowest values observed at the highest mixture of FYM and RS, as compared with other treatments. These data are in line with those obtained by Elia and Boulos (2019). While, the opposite attitude was observed in clay soil. Changes of hydraulic conductivity in clay soil may be due to its exposure to application of the studied amendments which causes changes in the pore size and the permeability of clay. Generally, incorporation of the studied amendments improved soil hydraulic conductivity. Application of organic materials can be considered helpful to slower the rapid leaching by decreasing the water movements into and within the soil (Leelamanie and Manawardana 2019).

The bulk density of all treated soils with FYM, PhR and RS were decreased with increasing of the addition rates. The reduction in bulk density may be related to the mixing of soil with less dense organic material or by enhancing the fine particle aggregation, leading to increase the pore volume. These findings are agreement with those obtained by Omran et al (2002). A normal value of bulk density for clay soils is ranged between 1.0 to 1.6 Mg.m^{-3} and the normal values for sand is ranged between 1.2 to 1.8 Mg.m^{-3}, plants have a potential restriction at ≥1. 4 Mg.m^{-3} for clay and ≥1.6 Mg.m^{-3} for sand (Corley 1984). Generally, the bulk density affects the hydraulic conductivity to the extent that the soils with higher bulk density were having correspondingly lower hydraulic conductivity (Igwe 2005).

Total porosity refers to the arrangement of solid particles in a soil, when particles lie close together it refers to compacted soils. The highest rates of FYM and Ph R mixed with RS were more effective than other treatments. Amendments can improve the soil hydro physical characteristics such as aggregate stability, permeability coefficient hydraulic conductivity and total porosity (Yazdanpanah et al 2016). The values ranged between 41.96 to 36.33%, 44.00 to 38.31 % and 44.72 to 40.70% for sandy, sandy loam and clay soils, respectively.

Table 4. Effect of the studied materials on soil physical properties

Treatments (ton. fed^{-1})		Sandy soil				Sandy loam soil (calcareous)				Clay soil			
		HC cmh^{-1}	Densities $Mg.m^{-3}$		Porosity %	HC cmh^{-1}	Densities $Mg.m^{-3}$		Porosity %	HC cmh^{-1}	Densities $Mg.m^{-3}$		Porosity %
			BD	PD			BD	PD			BD	PD	
Control		**25.50**	**1.70**	**2.67**	**36.33**	**8.57**	**1.61**	**2.61**	**38.31**	**1.80**	**1.53**	**2.58**	**40.70**
Farmyard manure (FYM)	5	24.50	1.65	2.60	36.54	7.25	1.54	2.61	41.00	1.82	1.50	2.55	41.18
	10	20.40	1.58	2.60	39.23	5.90	1.49	2.57	42.02	1.93	1.46	2.50	41.60
Phosphate Rock (Ph R)	5	25.00	1.70	2.67	36.33	8.00	1.60	2.60	38.46	1.85	1.48	2.58	42.64
	10	20.80	1.65	2.60	36.54	9.40	1.57	2.57	38.91	1.98	1.45	2.55	43.14
Rice Straw (RS)	5	26.00	1.62	2.60	37.69	7.00	1.57	2.53	37.94	2.00	1.48	2.50	40.80
	10	24.50	1.58	2.58	38.76	8.70	1.51	2.53	40.32	2.25	1.40	2.50	44.00
5 FYM + 5 RS		22.70	1.60	2.57	37.74	6.70	1.54	2.57	40.08	2.00	1.47	2.53	41.90
5 FYM + 10 RS		20.60	1.56	2.55	38.82	6.90	1.50	2.54	40.94	2.20	1.43	2.51	43.03
10 FYM + 5 RS		19.30	1.53	2.54	39.76	6.30	1.45	2.52	42.46	2.45	1.38	2.44	43.44
10 FYM + 10 RS		19.00	1.48	2.55	41.96	5.85	1.40	2.50	44.00	2.50	1.36	2.46	44.72
5 Ph R + 5 RS		22.00	1.62	2.61	37.93	8.90	1.55	2.61	40.61	2.00	1.45	2.49	41.77
5 Ph R + 10 RS		20.00	1.55	2.50	38.00	9.00	1.54	2.55	39.61	2.30	1.40	2.50	44.00
10 Ph R + 5 RS		20.00	1.61	2.55	36.86	8.50	1.52	2.57	40.85	2.32	1.40	2.46	43.09
10 Ph R + 10 RS		20.00	1.55	2.51	38.25	8.00	1.50	2.55	41.18	2.40	1.37	2.43	43.62
LSD	FYM (A)	4.82	-	-	3.26	2.66	-	-	5.34	0.80	-	-	3.66
	Ph R (B)	6.16	-	-	1.66	1.16	-	-	3.14	0.37	-	-	5.47
	RS (C)	4.70	-	-	1.80	3.22	-	-	4.74	0.58	-	-	2.82
	AC	4.92	-	-	2.41	2.73	-	-	3.85	0.59	-	-	3.66
	BC	5.30	-	-	2.85	2.85	-	-	5.29	0.50	-	-	5.47

3.3 Fresh and dry weight

Data in **Table 5** clear that fresh and dry weights were increased significantly with increasing the highest rates of farmyard manure (FYM) phosphate rock (Ph R) and rice straw (RS). In this concern, Buraka et al (2016) found that the application of FYM and P fertilizer had a significant influenced biomass yield of faba bean. FYM mixed with RS recorded the highest values of fresh and dry wrights compared with other treatments. This may be due to the role of applications of natural materials as a source of nitrogen, phosphorus and potassium which promoting and enhancing plant growth, the metabolic process and regulate water balance (Manning 2010). The highest values of FW and DW were 17.0, 4.45 $g.plant^{-1}$; 17.45, 4.65 $g.plant^{-1}$ and19.40, 6.12 $g.plant^{-1}$ in sandy, sandy loam and clay soils, respectively as compared to control. Enhancement of growth might be attributed to the role of farmyard manure and phosphate rock in increasing the nutrient availability, improving the soil properties. Application of organic manures have a considerable increase in plant growth of beans (Nawalagatti 2009).

3.4 Macronutrients content

From data in **Table 6** it is evident that the increasing in NPK content of faba bean associated by the increasing rates of FYM and Ph R and RS as alone or mixture. Integrated use of organic materials and fertilizers is effective in improving the availability of N, P and K (Rautaray et al 2003). The highest values of NPK content of faba were recorded 2.42, 0.48, 1.98%, 2.50, 0.48, 2.10%, and 2.55, 0.55, 2.25%, for sandy, sandy loam and clay soils, respectively. The highest values of N were recorded at 10 $ton.fed^{-1}$ FYM+10 $ton.fed^{-1}$ RS treatment. While, the highest values of P and K were recorded at 10 $ton.fed^{-1}$ of Ph+10 $ton.fed^{-1}$ RS in the studied soils. The increase in nutrients content resulted due to more available nutrients in the soil solution, which is probably promoted the well-developed root system in upper zone. The beneficial effects of phosphate rock, farmyard manure and rice straw are very important especially, in clay soil. The value of FYM as a fertilizer lies in the fact that it supplies macronutrients to the soil in addition to the improvement of the physio-chemical and biological properties of the soil, which helps to maintain the soil productivity and soil health (Sulieman et al 2009).

Table 5. Effect of the studied materials on fresh and dry weight of faba bean plant grown in different soils

Treatments (ton. fed^{-1})		Sandy soil		Sandy loam soil (calcareous)		Clay soil	
		FW g. $plant^{-1}$	DW g. $plant^{-1}$	FW g. $plant^{-1}$	DW g. $plant^{-1}$	FW g. $plant^{-1}$	DW g. $plant^{-1}$
Control		**11.90**	**2.92**	**12.11**	**3.70**	**15.80**	**4.10**
Farmyard manure (FYM)	5	13.80	3.00	14.34	4.00	16.70	4.70
	10	15.51	3.67	16.46	4.20	18.63	4.98
Phosphate Rock (Ph R)	5	12.98	2.95	14.27	3.90	16.50	4.21
	10	14.37	3.50	15.38	4.00	17.30	4.70
Rice Straw (RS)	5	12.00	2.95	14.20	3.80	16.00	4.11
	10	12.50	3.18	14.86	4.15	16.11	4.32
5 FYM + 5 RS		14.00	3.21	15.00	3.98	18.11	4.50
5 FYM + 10 RS		14.35	3.42	15.50	4.25	18.25	4.65
10 FYM + 5 RS		16.77	4.10	16.90	4.34	19.00	5.80
10 FYM + 10 RS		17.00	4.45	17.45	4.65	19.40	6.12
5 Ph R + 5 RS		13.30	3.17	15.38	4.00	17.80	4.54
5 Ph R + 10 RS		14.20	3.65	16.10	4.52	18.10	4.85
10 Ph R + 5 RS		15.70	3.27	15.90	4.21	17.87	4.86
10 Ph R + 10 RS		16.25	3.82	16.45	4.63	18.13	5.15
LSD	FYM (A)	1.50	0.20	1.35	1.28	3.18	1.29
	Ph R (B)	1.56	0.27	1.44	1.29	3.23	1.50
	RS (C)	2.56	0.32	0.52	0.66	3.01	1.42
	AC	2.16	0.34	3.14	1.55	3.05	2.81
	BC	0.49	0.24	2.30	1.28	1.88	2.47

Table 6. Effect of applying the studied materials on macronutrients (%) content of faba bean

Treatments (ton. fed^{-1})		Sandy soil			Sandy loam soil (calcareous)			Clay soil		
		N %	P %	K %	N %	P %	K %	N %	P %	K %
Control		**1.55**	**0.26**	**1.25**	**1.66**	**0.26**	**1.55**	**1.90**	**0.31**	**1.77**
Farmyard manure (FYM)	5	1.90	0.34	1.66	1.95	0.30	1.71	2.20	0.35	1.87
	10	2.20	0.37	1.73	2.25	0.35	1.78	2.40	0.40	1.90
Phosphate Rock (Ph R)	5	1.80	0.36	1.76	1.85	0.35	1.87	1.90	0.41	1.88
	10	1.90	0.40	1.80	1.80	0.40	1.90	2.00	0.45	1.95
Rice Straw (RS)	5	1.70	0.28	1.54	1.85	0.30	1.60	2.00	0.30	1.80
	10	1.82	0.30	1.60	1.90	0.35	1.65	2.20	0.35	1.85
5 FYM + 5 RS		2.00	0.36	1.70	2.00	0.30	1.75	2.30	0.37	1.95
5 FYM + 10 RS		2.25	0.39	1.76	2.00	0.34	1.80	2.50	0.40	2.00
10 FYM + 5 RS		2.30	0.40	1.90	2.45	0.40	1.85	2.50	0.45	2.00
10 FYM + 10 RS		2.42	0.44	1.98	2.50	0.45	2.00	2.55	0.48	2.20
5 Ph R + 5 RS		2.00	0.39	1.80	1.88	0.39	1.88	2.00	0.45	1.98
5 Ph R + 10 RS		2.20	0.45	1.90	1.95	0.45	1.95	2.20	0.50	2.15
10 Ph R + 5 RS		2.10	0.40	1.95	1.90	0.45	1.98	2.20	0.50	2.10
10 Ph R + 10 RS		2.35	0.48	1.98	1.95	0.48	2.10	2.35	0.55	2.25
LSD	FYM (A)	0.49	0.12	0.58	0.61	0.14	0.20	1.72	0.17	0.29
	Ph R (B)	0.35	0.17	0.22	0.16	0.22	0.91	1.62	0.13	0.26
	RS (C)	0.26	0.12	0.14	0.18	0.09	0.26	1.67	0.07	4.71
	AC	0.59	0.15	0.35	0.35	0.18	0.22	2.68	0.01	0.48
	BC	0.51	0.22	1.57	0.52	0.22	0.22	1.72	0.54	0.25

3.5 Macronutrients uptake

The illustrated data in **Figs 1 A, B and C, 2 A, B and C and 3 A, B and C** declared that N, P and K uptake by faba bean in sandy, sandy loam and clay soils, respectively. It could be noticed that there is a significant increase in the macronutrient uptake by increasing the use of farmyard manure, phosphate rock and rice straw in the studied soils. The pots received the highest rates of FYM and PhR (10 ton. fed^{-1}) mixed with the highest rate of RS (10 ton. fed^{-1}) gave the highest values of N, P and K uptake by faba bean in all studied soils. Similar results were also obtained by Mashori et al (2013) found that the P uptake and dry matter yield of crops enhanced by application of phosphate rock and farm yard manure. It noticed that the highest values of N uptake by faba bean plant were recorded at 10 ton.fed^{-1} FYM+ 10 ton.fed^{-1} RS treatment. Also, the highest values of P and K uptake by faba bean plant were recorded at 10 ton. fed^{-1} of Ph+10 ton. fed^{-1} RS in the calcareous soil. This trend could be due to increase of NPK availability in soil and the direct its uptake by faba bean plant resulting in high production of dry matter and higher content of macronutrients. While, the lowest values were recorded at control treatment. Phosphate rock offers a cheap source of P and an option for organic farming systems (Hellal et al 2019).

Also, the improving in macronutrients uptake refer to the improving soil properties, where the highest uptake of NPK were observed in sandy soil and sandy loam soil at the lowest value of hydraulic conductivity. The effect of hydraulic conductivity on nutrient uptake could be that water movement to the soil is the main source to plant growth and nutrients. These data are in line with those obtained by Thangasamy et al (2017). On the other hand, the highest values of NPK uptake in clay soil were increased by increasing the hydraulic conductivity. This may be due to the improvement of soil hydraulic properties leads to efficient use of water and fertilizers and good aeration and water retention. Soil porosity and hydraulic conductivity have affected on water availability and nutrient uptake by roots (Rasool et al 2008).

3.6 The linear relationships between some soil characteristics in sandy soil

The data presented in **Fig 4 A, B, C and D** show that hydraulic conductivity (HC), bulk density (BD) and total porosity (TP) are related to the changes in organic matter. Most pores in sandy soils are large and drain rapidly and sand particles have low cation exchange capacity; therefore, sandy soils have low nutrient, low organic matter and water retention capacity (Walpola and Arunakumara 2010). It was noticed that there are negatives correlation between both of OM and HC ($r = - 0.406$), and OM and BD ($r =- 0.668$). These finding are similar with those obtained by Gamie and Desmedt (2018). On the other hand, there is a positive correlation between OM and TP ($r = 0.697$). These results are in line with those obtained by Leelamanie and Manawardana (2019). These changes reflected on the plant growth, where observed that, there is a strong positive correlation (0.616) between OM and dry matter of faba bean plant.

3.7 The linear relationships between some soil characteristics in sandy loam soil

The data presented in **Fig 5 A, B, C and D** illustrated that hydraulic conductivity (HC), bulk density (BD) and total porosity (TP) are affected by the changes in organic matter content as a result addition of the studied materials. There are negative correlations between both of OM and HC ($r = - 0.858$); and OM and BD ($r = -0.784$). Hydraulic conductivity had a negative correlation with increasing organic matter (Bocuti et al 2020). On the other hand, there is a positive correlation between OM and TP ($r = 0.774$). These chances reflected on the plant growth, where observed that, there is a moderate positive correlation (0.442) between OM and dry matter of faba bean plant.

3.8 The linear relationships between some soil characteristics in clay soil

The data presented in **Fig 6 A, B, C and D** illustrated that hydraulic conductivity (HC), bulk density (BD) and total porosity (TP) are affected by the changes in organic matter content as a result addition of the studied materials. There are positive correlations between both of OM and HC ($r = 0.151$), OM and TP ($r = 0.051$). While, there is a negative correlation between OM and BD ($r = -0.104$). There are close relationships between soil organic matter and soil properties (Masi et al 2020). These chances reflected on the plant growth, where observed that, there is a strong positive correlation (0.593) between OM and dry matter of faba bean plant.

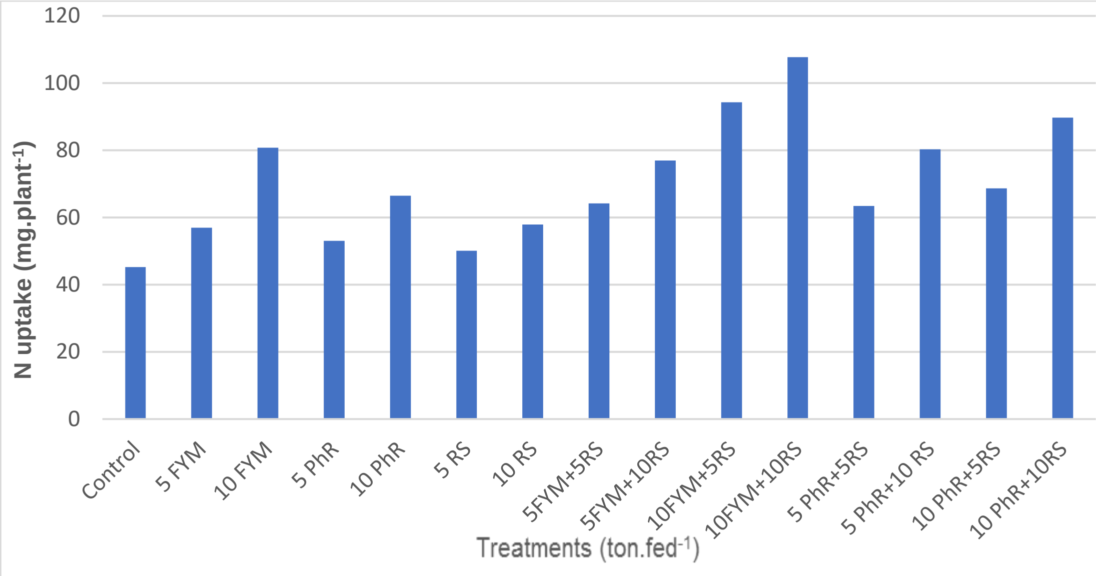

Fig 1A. N uptake (mg. plant^{-1}) by faba bean plant in sandy soil as affected by the studied materials

LSD at 5%: FYM (A)= 6.8, Ph R (B)= 5.74, RS(C)= 5.24, AC= 8.77 and BC= 9.37.

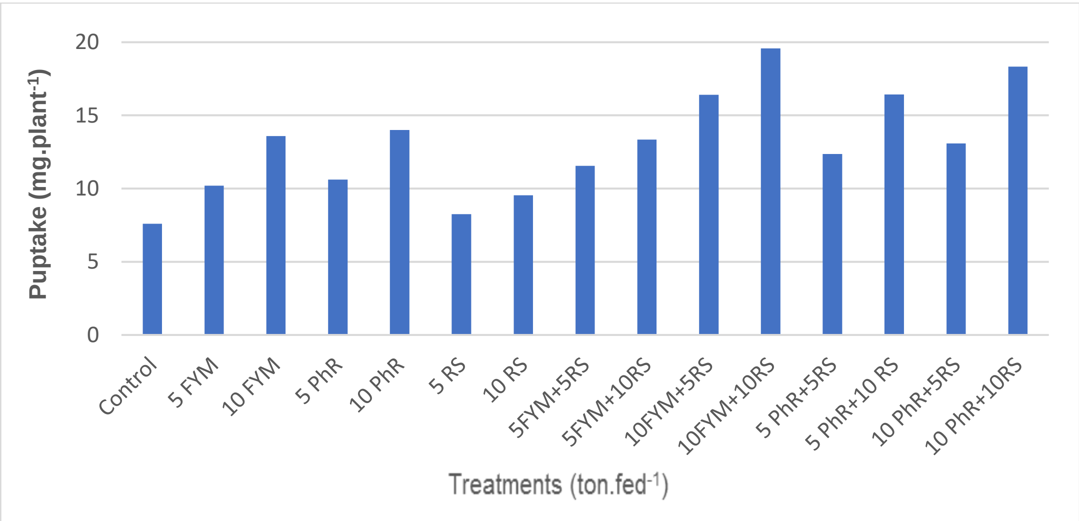

Fig 1B. P uptake (mg. plant^{-1}) by faba bean plant in sandy soil as affected by the studied materials

LSD at 5%: FYM (A)= 1.57, Ph R (B)= 2.22, RS(C)= 1.13, AC= 1.79 and BC= 1.28.

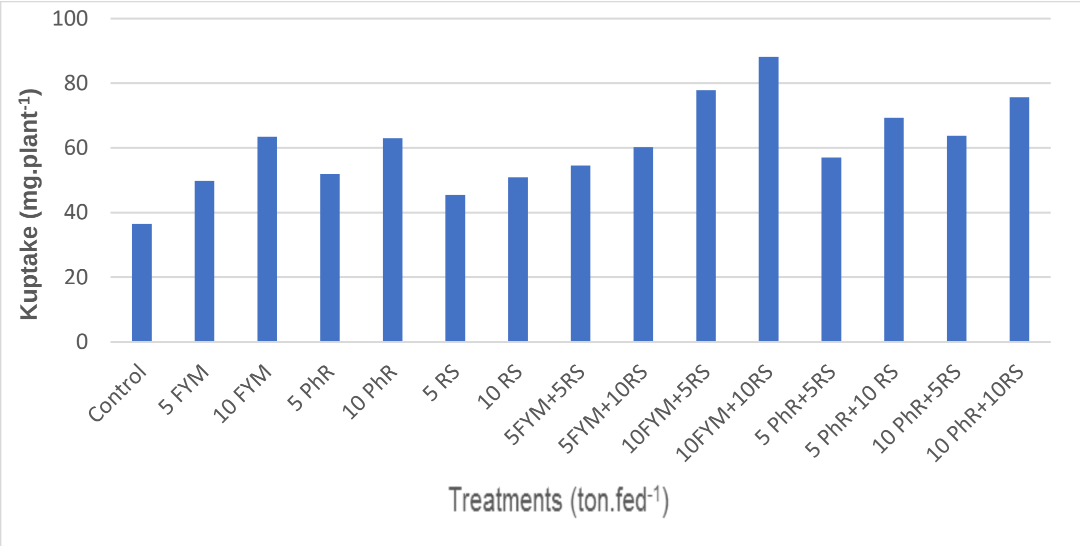

Fig 1C. K uptake (mg. plant^{-1}) by faba bean plant in sandy soil as affected by the studied materials

LSD at 5%: FYM (A)= 6.9, Ph R (B)= 5.26, RS(C)= 5.6, AC= 3.35 and BC= 5.54.

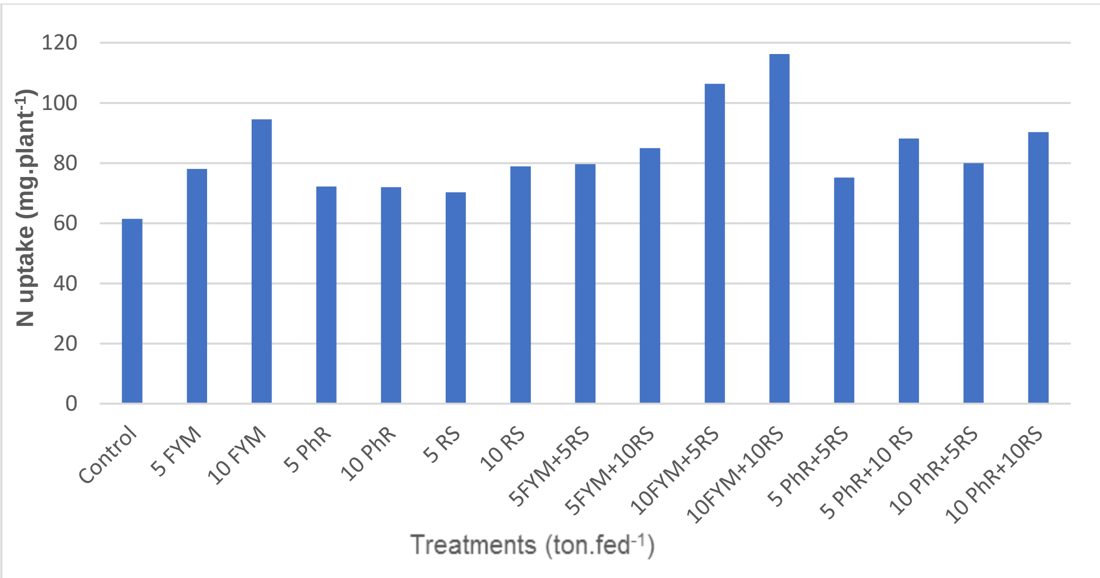

Fig 2A. N uptake (mg. plant^{-1}) by faba bean plant in sandy loam soil as affected by the studied materials

LSD at 5%: FYM (A)= 9.94, Ph R (B)= 10.8, RS(C)= 2.44, AC= 5.73 and BC= 4.06.

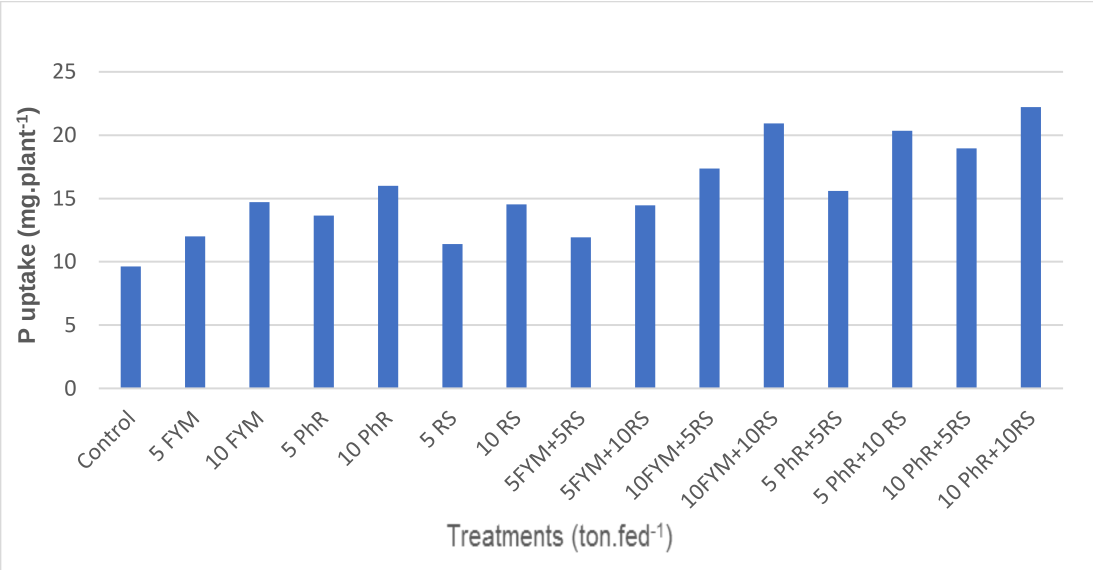

Fig 2B. P uptake (mg. plant^{-1}) by faba bean plant in sandy loam soil as affected by the studied materials

LSD at 5%: FYM (A)= 5.74, Ph R (B)= 6.24, RS(C)= 3.31, AC= 4.32 and BC= 3.35.

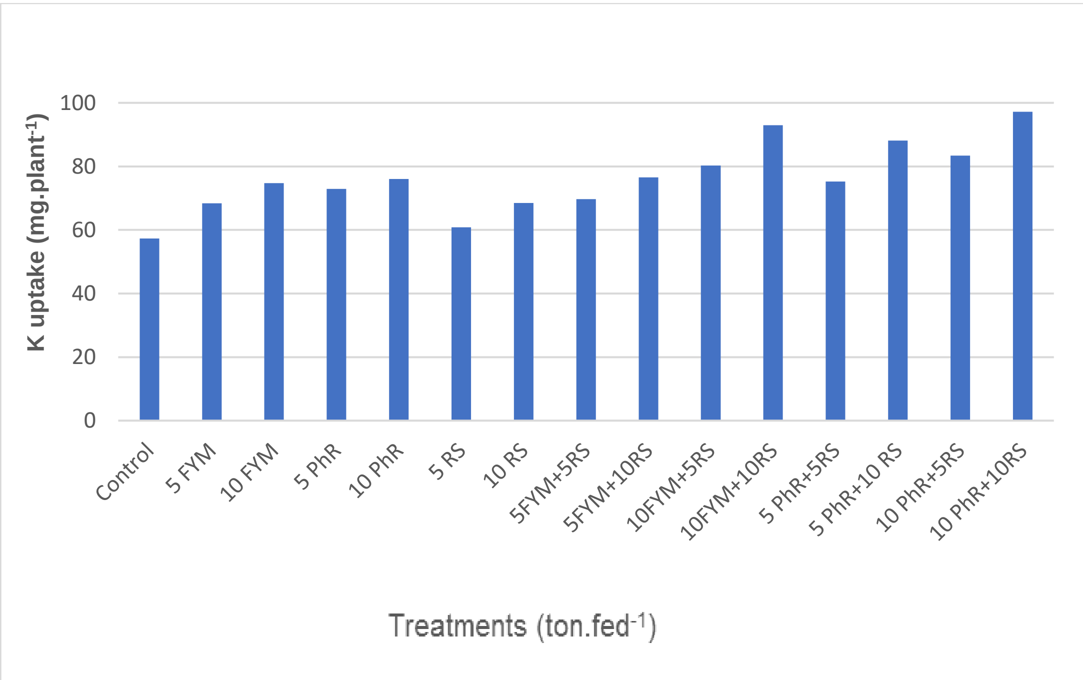

Fig 2C. K uptake (mg. plant^{-1}) by faba bean plant in sandy loam soil as affected by the studied materials

LSD at 5%: FYM (A)= 4.68, Ph R (B)= 8.9, RS(C)= 4.97, AC= 5.41 and BC= 4.77.

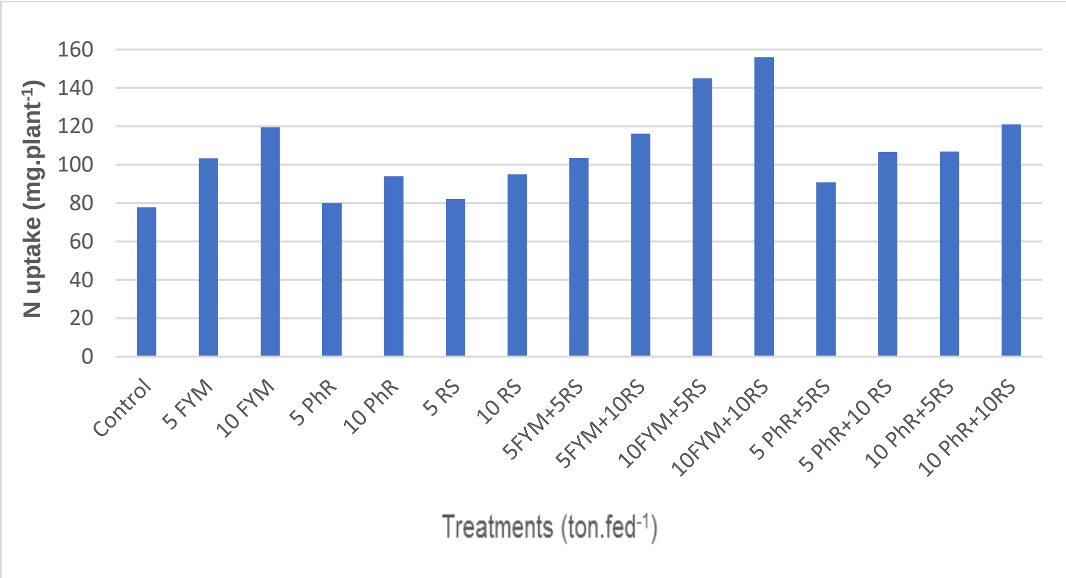

Fig 3A. N uptake (mg. plant^{-1}) by faba bean plant in clay soil as affected by the studied materials

LSD at 5%: FYM (A)= 8.97, Ph R (B)=8.12, RS (C)=7.45, AC= 11.23 and BC= 7.03.

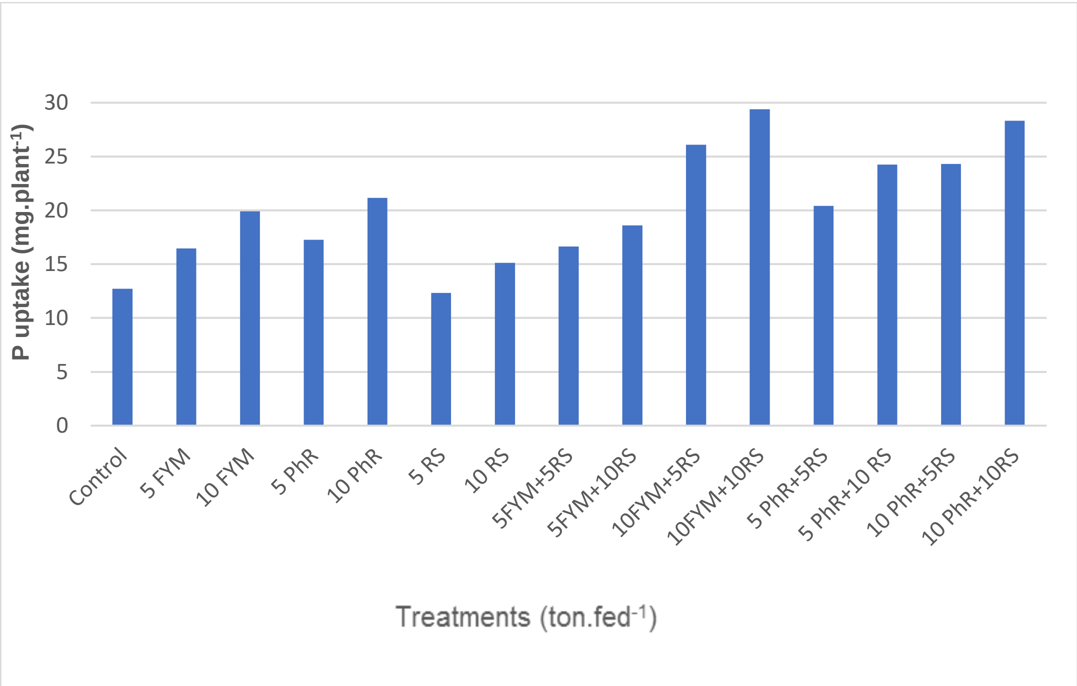

Fig 3B. P uptake (mg. plant^{-1}) by faba bean plant in clay soil as affected by the studied materials

LSD at 5%: FYM (A)= 0.23, Ph R (B)= 3.23, RS(C)=3.6, AC= 5.24 and BC= 6.12.

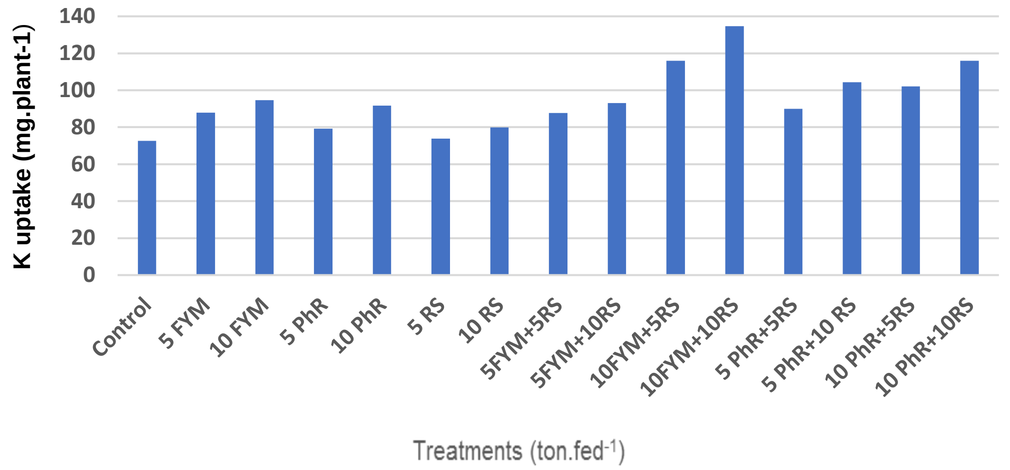

Fig 3C. K uptake (mg. plant^{-1}) by faba bean plant in clay soil as affected by the studied materials

LSD at 5%: FYM (A)= 9.6, Ph R (B)= 4.12, RS (C)= 8.45, AC= 6.62 and BC= 6.70.

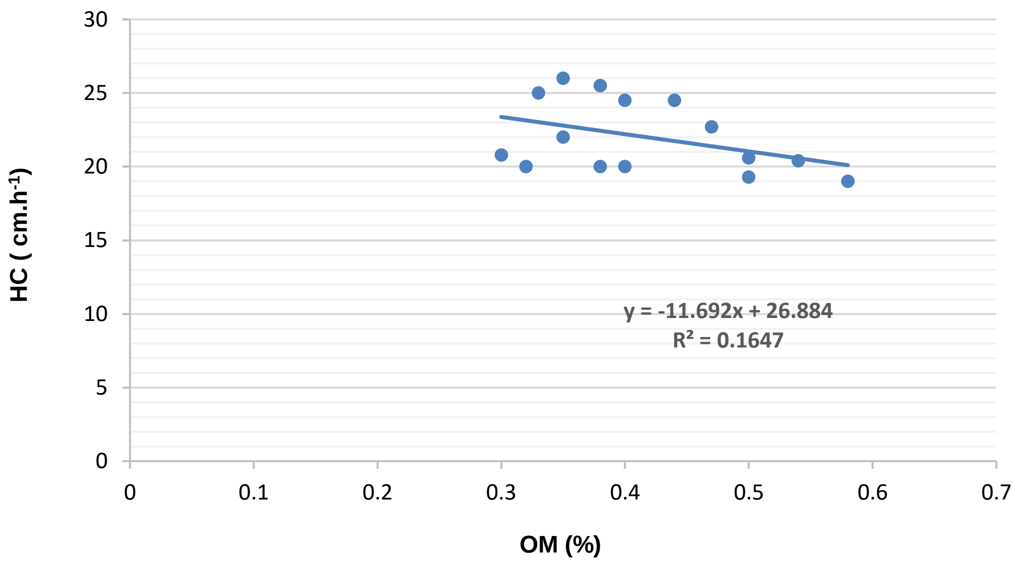

Fig 4A. The liner relationship correlation between organic matter (OM) and hudraulic conductivity (HC) in sandy soil. *r = -0.406*

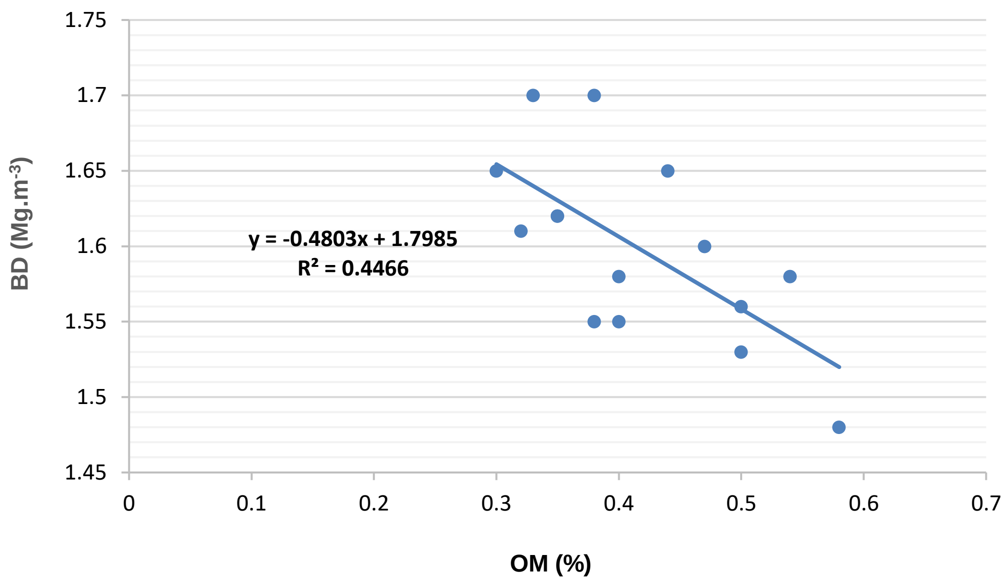

Fig 4B. The liner relationship correlation between organic matter (OM) and bulk density (BD) in sandy soil. *r* = - 0.668

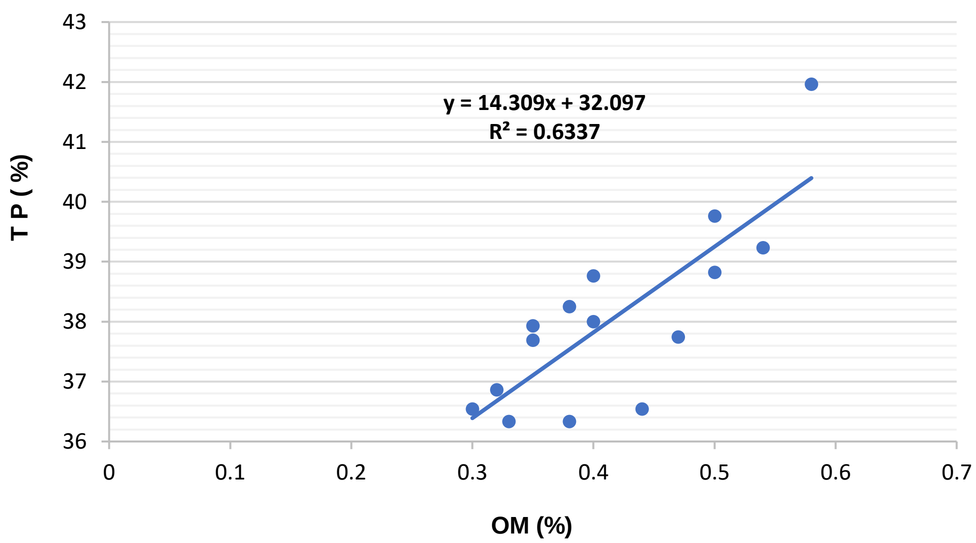

Fig 4C. The liner relationship correlation between organic matter (OM) and total porosity (TP) in sandy soil. *r* = 0.796

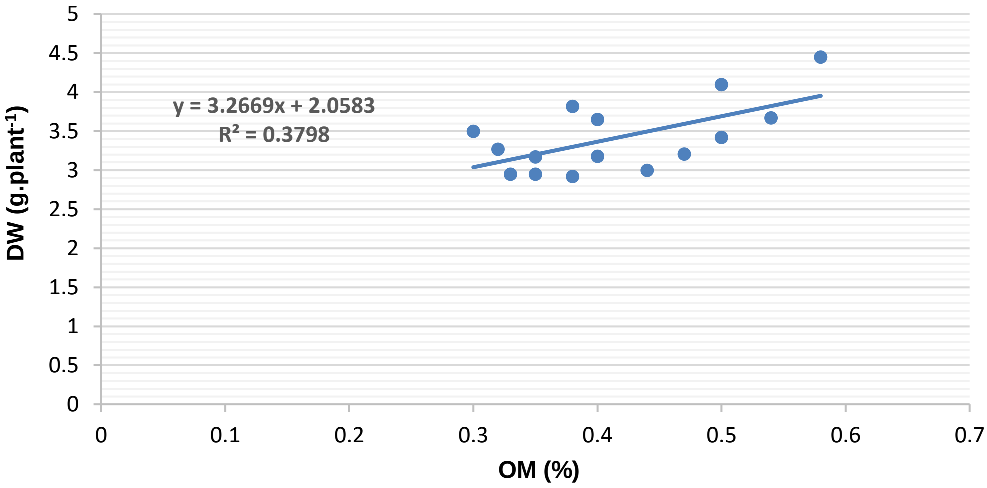

Fig 4D. The liner relationship correlation between organic matter (OM) and dry weight (DW) of faba bean plant grown in sandy soil. *r* = 0.616

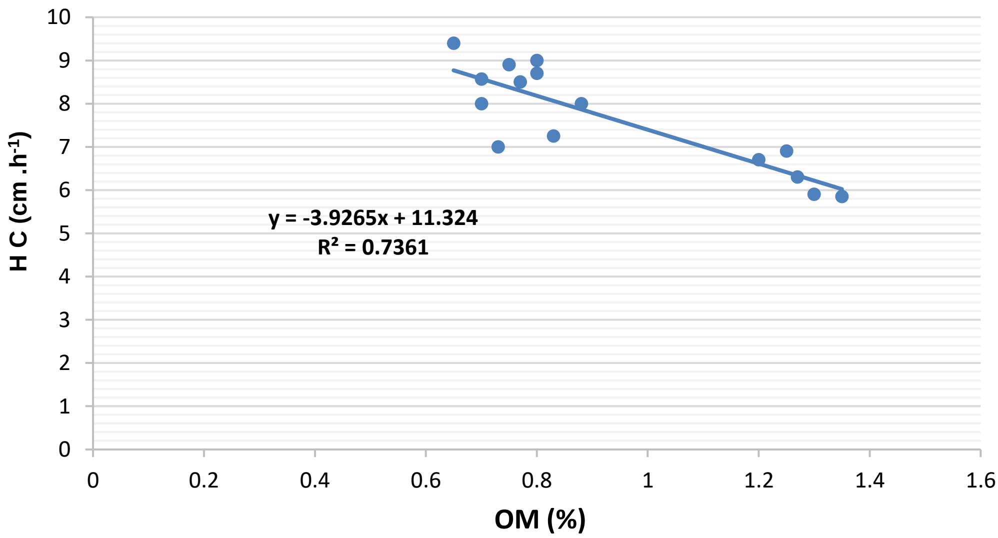

Fig 5A. The liner relationship correlation between organic matter (OM) and hydraulic conductivity(HC) in sandy loam soil. *r = -0.858.*

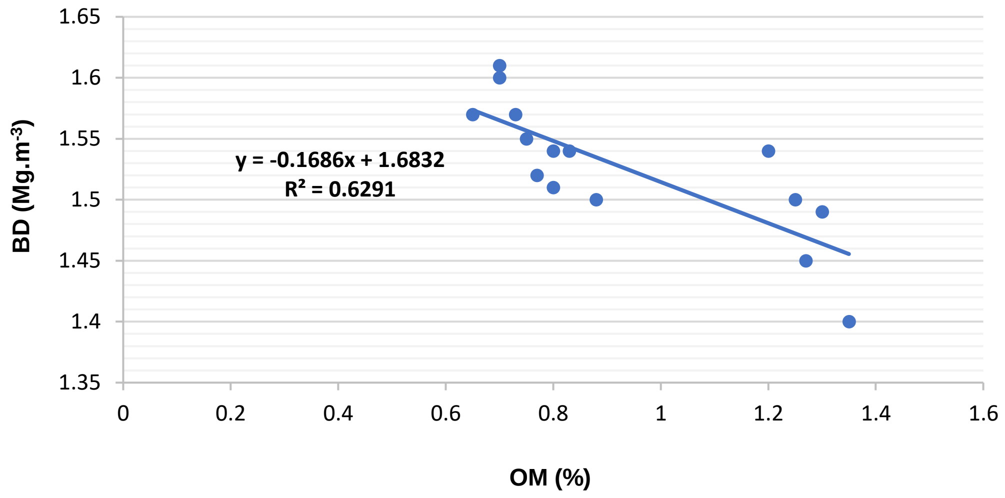

Fig 5B. The liner relationship correlation between organic matter (OM) and bulk density (BD) in sandy loam soil. *r = -0.784.*

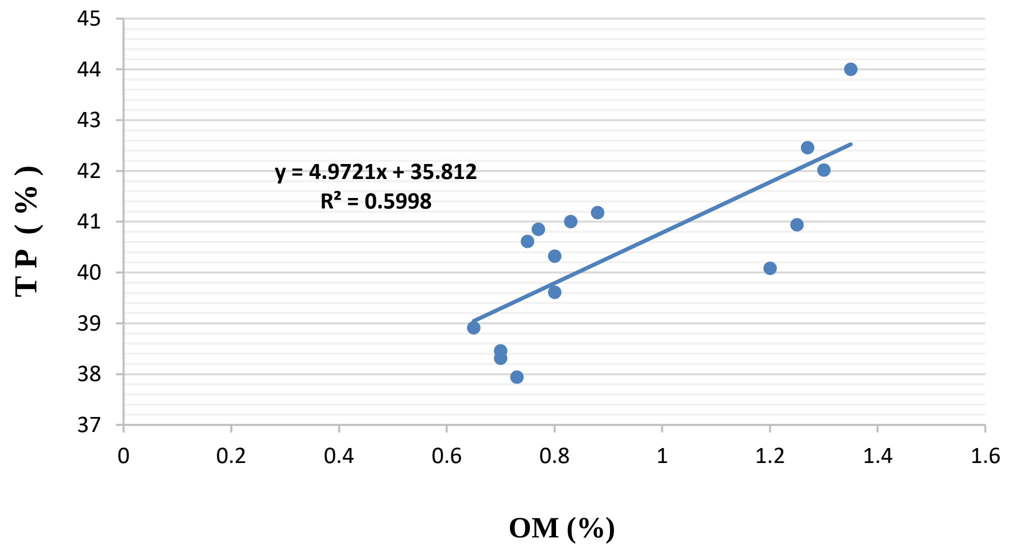

Fig 5C. The liner relationship correlation between organic matter (OM) and total porosity (TP) in sandy loam soil. *r = 0.774*.

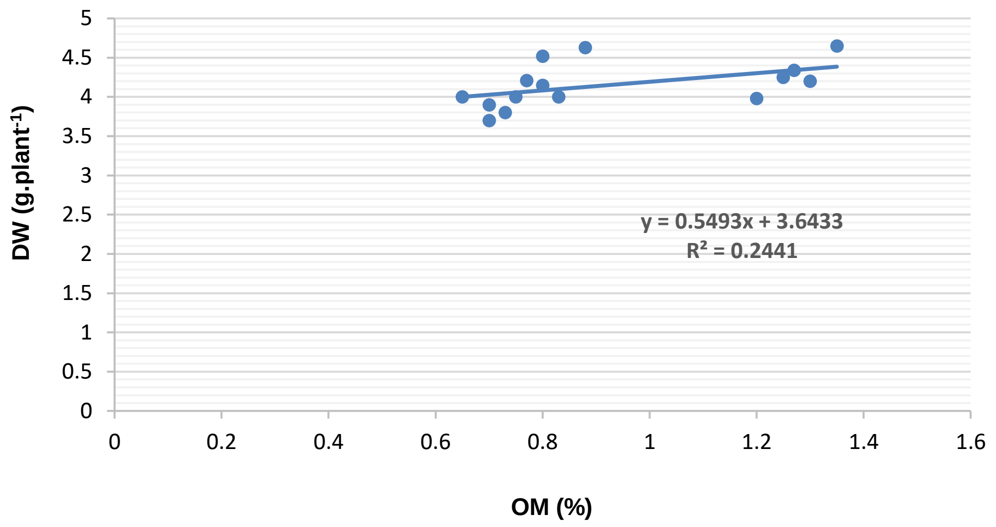

Fig 5D. The liner relationship correlation between organic matter (OM) and dry weight (DW) of faba bean plant grown in sandy loam soil. *r = 0.442.*

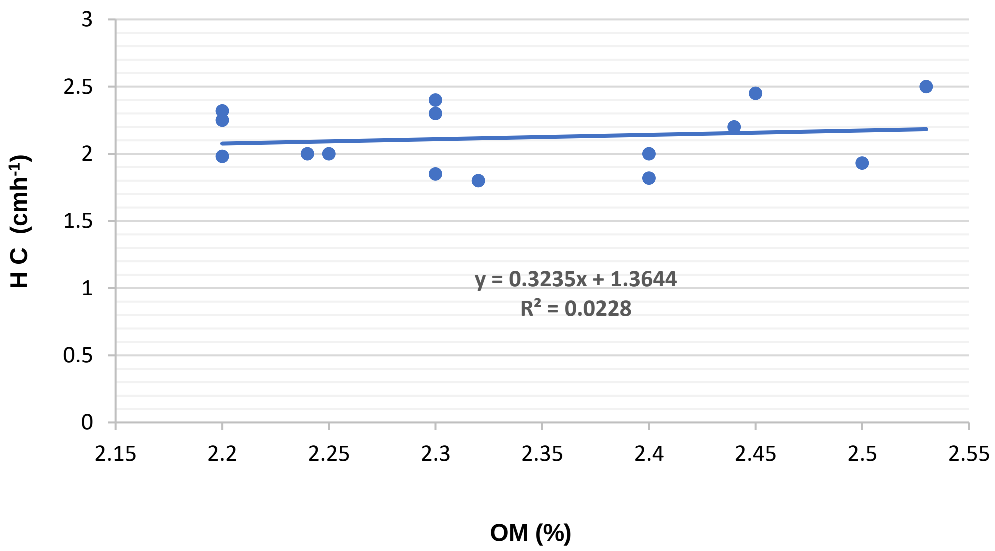

Fig 6A. The liner relationship correlation between organic matter (OM) and hydraulic conductivity (HC) in clay soil. *r = 0.151*.

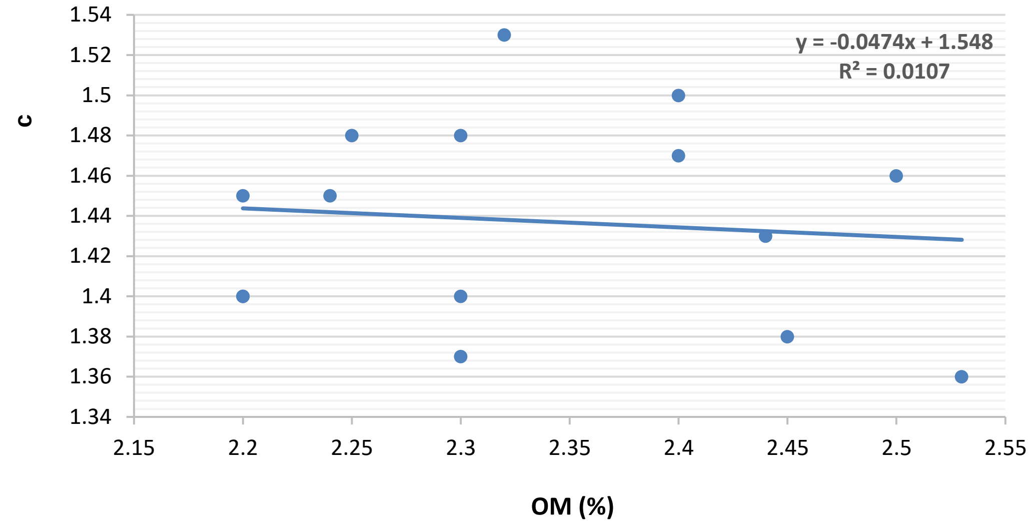

Fig 6B. The liner relationship correlation between organic matter (OM) and bulk density (BD) in clay soil. *r = -0.104*.

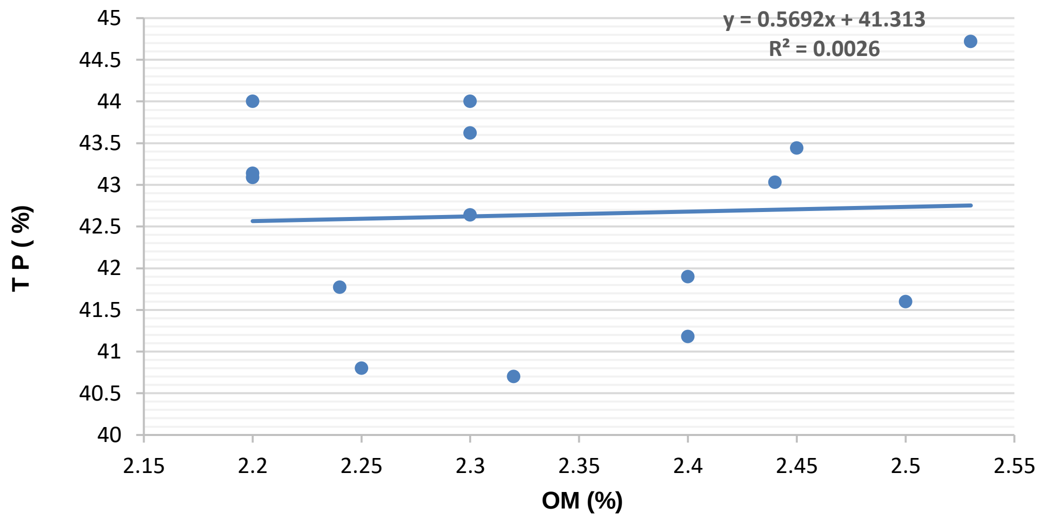

Fig 6C. The liner relationship correlation between organic matter (OM) and total porosity (TP) in clay soil. *r = 0.051*.

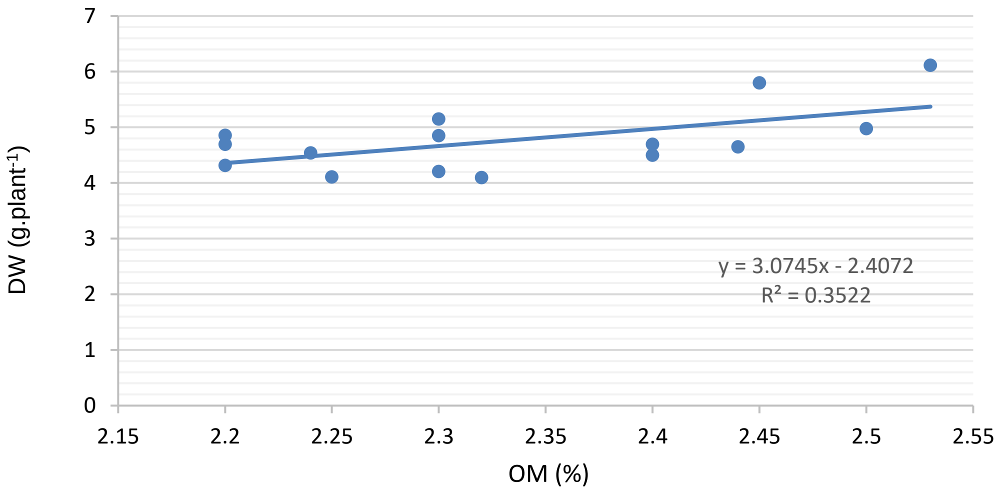

Fig 6D. The liner relationship correlation between aorganic matter (OM) and dry weight (DW) of faba bean plant grown in clay soil. *r = 0.593*.

4 Conclusion

It was concluded that the addition of natural amendments (FYM, PhR and RS) improved the most of physical and chemical properties of the studied soils. Generally, there are negative correlations between soil organic matter and both of hydraulic conductivity and bulk density in the studied soils, except, organic matter and hydraulic conductivity gave appositive effect in clay soil. Changes in soil properties especially, organic matter, hydraulic conductivity and soil porosity gave a significant increase in faba bean growth and nutrients uptake. It could be concluded that the best treatment for plant growth, NPK content and uptake by faba bean plants were obtained by the addition of FYM and Ph R as a mixture with RS. Also, this is a solution to address the black cloud problem. By giving alternatives that can be applied to maximize the benefits of rice straw. The research needs other specialized research to reach sustainable development in the agricultural sector.

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مجلة اتحاد الجامعات العربية للعلوم الزراعية، جامعة عين شمس، القاهرة، مصر
مجلد(28)، عدد(4)، 1295-1316، 2020
Website: http://ajs.journals.ekb.eg

أهمية بعض المصلحات الطبيعية لتحسين خواص التربة ونمو النبات

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Received 24 September, 2020 Accepted 25 October, 2020

الموجـــــــــز

أجريت الدراسة بهدف تحسين بعض الخواص الطبيعية والكيميائية لأراضى مختلفة القوام (رملية، طمبية رملية، طينية) وكذا دراسة الإرتباط بين بعض خواص التربة وتأثير ذلك على نمو نبات الفول البلدى ومحتواه من العناصر الغذائية. لتحقيق هذا الهدف تم تصميم ثلاث تجارب اصص (عاملية) بإستخدام بعض المحسنات الأرضية الطبيعية (سماد المزرعة، صخر الفوسفات وقش الأرز) بمعدلات 0، 5، 10 طن/فدان بصورة منفردة او بخلط صخر الفوسفات وسماد المزرعة بقش الأرز، تم إضافة هذه المعاملات أثناء إعداد الارض للزراعة، مع التحضين لفترة 15 يوم قبل الزراعة. أظهرت النتائج وجود زيادة معنوية فى محتوى المادة العضوية والمسامية الكلية مع زيادة معدلات إضافة صخر الفوسفات وسماد المزرعة مع قش الأرز، كما تأثرت ملوحة التربة تأثراً غير معنوياً بإضافة المواد المستخدمة. على الجانب الآخر لوحظ إنخفاض فى رقم الحموضة والكثافة الظاهرية مع زيادة معدلات الإضافة من المواد الطبيعية المستخدمة، كما إنخفض التوصيل الهيدروليكى في الآراضى الرملية والطميية رملية عند المعدلات المرتفعة من صخر الفوسفات وسماد المزرعة بصورة منفردة او مختلطة مع قش الأرز. بينما أعطت إضافة المعدلات المرتفعة من المواد المدروسة بالصورة المختلطة زيادة فى قيم نفاذية التربة الطينية. كما لوحظ أن هناك إرتباط سلبي بين المادة العضوية وكل من التوصيل الهيدروليكي والكثافة الظاهرية لجميع أنواع الآراضى محل الدراسة، ماعدا المادة العضوية والتوصيل الهيدروليكي فى الأرض الطينية حيث أعطت إرتباطاً إيجابياً. وكذا لوحظ إرتباطاً إيجابياً بين المادة العضوية والمسامية فى جميع أنواع الآراضى المدروسة. كما أدت هذه المعاملات إلى زيادة معنوية في الوزن الطازج والجاف لنبات الفول البلدى ومحتواه من العناصر الغذائية الكبري وخاصة مع زيادة معدلات إضافة سماد المزرعة وصخر الفوسفات بصورة مختلطة مع قش الأرز مقارنة بباقى المعاملات. مما يشير إلى أهمية إستخدام مثل هذه المواد الطبيعية خاصة فى الصورة المختلطة مع قش الأرز فى تحسين خواص الآراضى المختلفة، مما إنعكس ذلك إيجابياً على نمو النبات وإمتصاص العناصر المغذية.