J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 9 (12): 723 - 734, 2018

Interference between Organic Soil Conditioners Mixed with Synthetic Soil Conditioners to Improve Sandy Soil Productivity

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ABSTRACT

A field experiment was carried out for two successive winter and summer seasons (2016-2017) at Ismailia Agric. Res. Station in Ismailia Governorate, Egypt using wheat (*Triticum sativa* cv Giza 168) and peanut (*Arachi shypogaea* cv Giaz 5) crops to study the effect of organic soil conditioners individually or mixed with synthetic soil conditioners on physical and chemical properties of sandy soil, nutritional status and plant productivity. The experiment was arranged in split plots design with three replicates. Five forms of organic soil conditioners were applied as main plot consists of control (NPK), yeast sludge (YS) at rate of 2 kgfed^{-1}, commercial humic acids (HA at rate of 1 kgfed$^{-1)}$, seaweed extract (SWE) at rate of 100 g fed^{-1} and filter mud (FM) at rate of 5 kgfed^{-1}). While the sub main plot using synthetic soil conditioners as zero addition, carboxymethyl cellulose (CMC) at rate 2% and polyvinyl alcohol (PVA) at rate 0.2 %. Results cleared that the interference usage of organic soil conditioners in combination with synthetic soil conditioners had positively affect hydro-physical properties of the soil, i.e., decreasing soil bulk density, increasing total porosity along with dry stable aggregate, as well as, the superior treatment is SWE + CMC. In general, there is no valuable difference between SWE and organic residues, whereas, YS and FM have the same trend over to control. In addition, organic matter (OM) and available macronutrients N, P and K content in soil were increased significantly with all treatments applied compared to control, the maximum increases were observed with SWE application mixed with CMC. An opposite trend was obtained with both pH and EC values which generally decreased at all applied treatments especially with (SWE+ CMC) Therefore, the application of seaweed as organic soil conditioner individually or mixed with CMC or PVA which increased significantly both wheat and peanut biological yields, straw grain and/or seed, along with total N, P and K content as compared to either control or other organic treatments application. Moreover, obtained results showed highly significant correlation ($p< 0.05$) between grain and/or yield and soil EC, OM, P and N in spite of none significant correlation with pH and K. Finally, it can be concluded that organic soil conditioner especially seaweed and sugar cane byproduct was enhanced and became more effective when applied with polymers especially CMC.

Keywords: soil conditioner, organic residues, humic acid, seaweed, filter mud, chemical and physical soil properties, wheat and peanut plant

INTRODUCTION

In Egypt, many crops occupy high ranking for food needed like wheat plant, but its area produced only about 30% of the domestic needs. Also, Peanut (*Arachis hypogaea* L.) is grow well in arid and semi-arid regions and its seeds contain high amounts of edible oil (43 - 55%), protein (25-28%) and minerals (2.5%) (AbouKheira, 2009). There are different ways for increasing plant production; one of them is the appropriate application of organic residues, especially in the newly reclaimed areas.

Organic residues is commonly applied to the soil to hence improve their biological, chemical and physical, properties because it is consider a key component of the soil due to it carries out many functions in agro-ecosystem (Weil and Magdoff, 2004 and Celik, *et al*., 2004).

Yeast sludge is the by-product of sugarcane industry. It gets after fermentation of the solids that are separated from spent wash and dried. According to the nature of molasses and chemicals used in manufacturing of rectified spirit the chemical composition of yeast sludge was varies widely. The yeast sludge is known to contain good amount of proteins, major and micronutrients. Deshmane (1975) stated that yeast sludge contained relatively more quantities of arabinose, galactose, glucose and xylose sugars. Also, contained more inorganic nitrogen and less unhydrolysable nitrogen than FYM.

In addition, humic acid (HA) is an important part of soil organic structure. It has been used for improving soil conditions and plant growth (Fagbenro and Agboola, 1993) because humic acids have enhanced enzyme activity, plant nutrients, and growth stimulant (Lee and Bartlett, 1976). Humic acid contains about 51% to 57% C, 4% to 6% N and 0.2% to 1% P and other micronutrients in minute amounts. (Khattak and Muhammad, 2006). Soil can bring appreciable increase (up to 20%) in yields of wheat, maize, cotton, sugar beet and groundnut by applying 1.0 kg·ha^{-1} humic acid to the soil as well as improvement in their physico-chemical properties.

Seaweeds are macroscopic algae, growing in intertidal and subtidal regions of the sea, and serve as an excellent source fertilizer, and industrial raw material (Parthiban *et al*., 2013). Recently, marine algae used in agricultural as bio-fertilizers to improve their yield and quality and to reduce the negative environmental impact because it have bioactive substances such as essential fatty acids, vitamins, amino acids, minerals, and growth promoting substances alginic acid and mannitol (Houssien *et al*., 2011 ; Ismail and El-Shafay, 2015; Pacholczak *et al*., 2016a).

The utilization of seaweeds as biofertilizer was considered to compensate for the lack and deficiency of N, P and K in soils (Tuhy *et al*. 2015; Singh *et al*., 2016 and Vyomendra and kumar, 2016). Seaweed also enhanced water uptake as a direct result of the increased root growth of seaweed treated plants which increases a plant's drought tolerance by stimulate changes in the plant's metabolic pathways and allowing roots access to moisture not normally available to plants.

Also, filter mud, is produced as a by-product of sugarcane industries and characterized as a soft, spongy, amorphous, and dark brown to brownish material. (Ghulam *et al*., 2012). In spite of these waste residues present a problem for disposal; therefore, it was through useful to use residues as an organic source due to may produce different types of organic acids during microbial decomposition (Bhattacharyya *et al*., 2003). Filter mud also increased phosphorus availability, because it produces various ions on decomposition, which compete with phosphate for binding sites in soils (Arafat, 1994) and improves soil physical conditions (Sagare *et al*., 2001) also used as a soil conditioner (Singh *et al*., 2005a). Moreover, sugar cane filter mud is a good source of available N when applied to soil and its application can reduce the amount of fertilizer nitrogen required for optimum crop yield and play a role in decreasing the pollution effect of excessive N mineral fertilizer in soil (Arafat *et al*., 1997 and Yassen *et al*., 2002).

On the other hand, sandy soil usually has poor characteristics (surface area, water retention, organic matter content, fertility and weak ability to retain water (Abdel Hady, 2005). The addition of different synthetic conditioners (carboxymethyl cellulose and polyvinyl alcohol) could overcome those problems. Polymers can benefit plants in the various stages of development: germination, growth, evapotranspiration, flowering, and fruit formation.

Biopolymers (CMC) have a naturally occurring polysaccharide cellulose base. CMC is made commercially by reacting chloroacetic acid with sodium cellulose in slurry with isopropanol and water. CMC based superabsorbent products were produced during the 1970s and early 1980s (Buchholz and Graham, 1998). However, while cost of the reactants required to produce CMC are relatively cheap, there is a significant cost for the purification needed for most applications.

In addition, polyvinyl alcohol (PVA) is a synthetic hydrophilic polymer, which can degrade with the help of bacterial enzymes. It can absorb large volume of water, thus is a potential water retention material.PVA is more effective in stabilizing the soil surface at very low application rates than root exudates and soil organic matter, due to its strong adsorption (Akelah, 2013).

However, polymer addition to sandy soil was increased water use efficiency for plants (Sivapalan, 2001). The germination process, plant growth, nutrients uptake, yield and both water and fertilizer use efficiency were beneficially increased by mixing the plant pits in sandy soil with hydrogels (El-Hady *et al*., 2002).

Furthermore, Ali (2011) found that bulk density of the soil was decreased by added CMC individually or mixed with organic soil conditioner. As well as, increased of availability of N, P and K in soil may be due to the availability of sufficient moisture around the root concentrated, and thus a greater reproduction of root biomass resulting in the higher absorption of nutrients and water leading to production of higher vegetative biomass (Singh *et al*., 1997). Also, applications of organic amendments lead to change in soil pH likely due to the low buffering capacity (Neilsen *et al*., 1995).

El-Hady and Abo-Sedera (2006) concluded that the synthetic soil conditioning generally led to decreasing soil pH, increasing OM, organic carbon, total nitrogen % in the soil, and hence the possibility to save and provide available forms of N to growing plants, increasing N, P and K in treated soil. Along with, Ali (2011) added that applied of CMC in combination with organic conditioners had positively affect on hydro-physical properties of the soil, i.e., improving soil structure, decreasing soil bulk density, increasing retained moisture in the soil at all suctions under study (from 0 - 15 atmo), hydraulic conductivity and permeability for vertical flow of water through soil profile.

The objective of this study was to improve sandy soil properties and increase its productivity by using different sources of organic conditioners either alone or mixed with synthetic soil conditioners.

MATERIALS AND METHODS

Description of experimental field

A field experiment was carried out for two successive winter and summer seasons (2016-2017) at Ismailia Agric. Res. Station in Ismailia Governorate, Egypt (Latitude, 30^{o} 35' 41.901" N and longitude, 32^{o} 16' 45.834" E) using wheat (*Triticum sativa* cv Giza 168) and peanut (*Arachi shypogaea* c.v. Giaz 5) crops to evaluate the effectiveness of organic soil conditioners in combination with synthetic soil conditioners on chemical and physical properties of sandy soil, nutritional status and plant productivity. The characteristics of investigated soil before cultivated are shown in Table (1).

Table 1. Some physical and chemical properties of experimental soil

Soil properties			
Particle size distribution		**Soil physical properties:**	
Coarse sand%	69.0	Bulk density gm cm^{-3}	1.73
Fine sand%	24.7	Total porosity %	34.7
Silt%	3.52	SP	23.0
Clay%	2.83		
Soil texture	Sandy		
Chemical soil properties			
Organic matter%	0.36		
pH (1:2.5)*	7.73		
EC dSm^{-1} (1:5)**	0.44		
Soluble cations (meq L^{-1})		Soluble anions (meq L^{-1})	
Ca^{++}	1.02	CO^{-}	-
Mg^{++}	0.99	HCO_3^{-}	1.92
Na^{+}	1.30	Cl^{-}	1.20
K^{+}	1.00	SO_4^{--}	1.19
Available macronutrients			
N (mg kg^{-1})	39.0		
P (mg kg^{-1})	8.10		
K mg kg^{-1})	50		

***Soil water suspension ** Soil water extract**

Before cultivation, the usual agricultural practices were applied according to agricultural guidance for each crop. Super phosphates (P_2O_5 15%) in rate of 200 kg fed^{-1} was applied on soil surface during preparation soil for cultivation of both wheat and peanut plants respectively. Potassium sulfate (48% K_2O) was applied at rate of 50 kg fed^{-1} for winter and summer crops, respectively, in two split equal doses at sowing and after 30 days from planting. In addition, wheat plant received 120 kg fed^{-1} nitrogen in the form ammonium nitrate (33% N) in three every 20 days from planting whereas, peanut plant received 100 kg fed^{-1} nitrogen in two split equal doses at sowing and after one month from planting. Organic soil conditioners were applied in two equal doses during cultivation. All treatments were dissolved in 600 liter water and applied by sprayed on soil surface during soil preparation and after 30 day from sowing. Synthetic soil conditioners were applied in the same way before cultivation in one dose.

Experimental design and treatment details

The experiment consists of 15 treatments with three replicates and arranged in a split plot design. Five forms of organic soil conditioners were applied as main plot consists of:

1- Control (NPK) without soil conditioners addition
2- Yeast sludge (YS) at rate of 2 kg fed^{-1}
3- Commercial humic acids (HA) at rate of 1 kg fed^{-1}.
4- Seaweed (SWE) at rate of 100 g fed^{-1}
5- Filter mud (FM) at rate of 5 kg fed^{-1},

While the sub main plot occupied with synthetic soil conditioners as:

1- Without synthetic soil conditioner (WCP).
2- Carboxymethyl cellulose (CMC) at rate 2% in the form Na-CMC with medium viscosity 400-800 cP (2% aqueos solution, 25 °C).
3- Polyvinyl alcohol (PVA) at rate 0.2 % with an average M.W. of 125,000 (degree of hydrolysis: 86-89%)

Some chemical properties of raw materials are shown in Table (2).

Table 2. Some chemical properties of tested materials

Source	Yeast sludge	Commercial humic acid	Seaweed extract	Filter mud
	El Anglo Co.	Black earth Co.(Canada)	El Anglo Co.	El Anglo Co.
Composition	Byproducts of fermentation process during converting molasses to alcohol and vinass	The final product of compost decomposition by acids	Marin algae collected from the sea surface	The sediment or final residual from sugar can to sugar
N%	1.46	5.18	0.50	0.42
P%	0.177	0.077	0.277	0.135
K%	16.0	3.0	16.0	14.8
pH (1:2.5 suspension)	7.38	9.57	8.95	6.99
EC dSm^{-1} (1:5 extract)	7.24	1.27	5.03	7.61
OM %	0.37	0.45	1.35	0.15

Yield and soil samples:

Wheat and peanut plant samples were taken at harvested stage in one square meter to determine yield components by weight straw and grains yield. Plant samples were oven dried at 70 ^{0}C for 48 hr, up to constant dry weight, then ground and digested using H_2SO_4 and H_2O_2 mixture for nutritional status determinations (N, P and K) as described by (Page *et al.*,1982).

Soil physical analysis:

1- Bulk density

The soil was transferred from the sample holders of core sampler to a container and placed in an oven at 105^{o}C, and dried to constant weight. The weight of soil was recorded and bulk density was calculated by the formula of Black and Haratge (1986).

$$\textbf{Bulk Density } (\boldsymbol{\rho}) = \frac{\textbf{Oven dry weight soil}}{\textbf{Sample volume}}$$

2- Total Porosity

Total porosity of the soil was calculated from bulk density assuming a particle density of 2.65 g/m3 with the following formula:

$$\textbf{Total Porosity} = \mathbf{1} - \frac{\textbf{Bulk density}}{\textbf{Particle density}}$$

3- Aggregate stability:

Dry sieving stability (D.S.S):- Stability of dry aggregates was determined according to Richards (1954). The disturbed soil samples crushed by hand and passed through 10.0 mm sieve. Then 100 g soil sample placed on the top sieve of a set having openings 2, 0.5, 0.25, 0.125 and 0.063 mm. The sieves were gently shaken for 30 minutes and the fractions remaining on each sieve were weighed. Dry sieving stability (D.S.S) calculated by using the following equation:-

$$\textbf{D.S.S} = \frac{\sum \textbf{n x 100}}{\textbf{N}}$$

Where:-

n= weight of dry sieving fraction in (g).

N= weight of soil sample used in the dry sieving (g)

Soil chemical analysis:

Soil samples were taken after harvested air-dried, and passed through 2 mm sieve for analysis according to Cottenie *et al*. (1982) as follow:

1- Electrical conductivity (EC) dSm^{-1} in soil water extract at ratio (1:5).
2- pH in soil water suspension at ratio (1:2.5).
3- Organic matter (OM) and available N, P and K.

Statistical analysis:

All obtained results in each growing season were exposed to statistical analysis to compare the means through L. S. D. test at level of significant (0.05) as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Impress application of organic and synthetic soil conditioner on physical and chemical soil properties:

Soil physical properties:

A- Soil bulk density and total porosity:

Data recorded in Table (3) indicated that, mean values of soil bulk density of sandy as affected by used all organic treatments were relatively decreased from 1.57 to 1.39 g/cm^3 for soil cultivated with wheat plant while decreased from 1.5 to 1.31 g/cm^3 for soil cultivated with peanut. Also, the maximum decrease was found with seaweed (SWE) treatment over to control treatment. This probably due to the favorable effect of organic matter content on soil structure, which was reflected on the soil bulk density. Obtained results, also, agree with Khan *et al.* (2012) who stated that the soil bulk density was decreased and total porosity increased with the increasing level of filter mud application as organic soil conditioner from 10 tons ha^{-1} to 100 tons ha^{-1}.

In addition, with respect to the effect of synthetic soil conditioners, mean values show that the presented results agree with the findings of Koupai *et al.* (2008) who reported that absorbent polymers positively affect soil density, compactness, texture, aeration, water retention and available water.

Moreover, the interaction effect of organic and synthetic soil conditioners on soil bulk density was high significant decrease in seaweed in combination with CMC over to control.

On the other hand, total soil porosity is an index of the relative volume of pores in the soil; it is a special formula which explains the relationship between both the soil real and bulk densities. Data presented in Table (3) showed that the highest value of total soil porosity was found in the soil treated with combined of seaweed and CMC. The relative increases of total porosity were 19.9 % for soil treated with SW and CMC compared with control (zero addition).The increase in total porosity is especially important to crop development because it may have a direct effect on soil aeration and can enhance root growth. These results are in harmony with Sugiyanto *et al*. (1986) and Ghazy *et al*. (2000) who mentioned that the soil bulk density was decreased but the total porosity increased as resultant of applied CMC.

Table 3. Effect of different organic and synthetic soil conditioner on soil bulk density and total porosity after cultivation of both wheat and peanut crops

Organic soil Conditioners	Synthetic Soil conditioners	Wheat		Peanut	
		BD (g cm^{-3})	T. Porosity (%)	BD (g cm^{-3})	T. Porosity (%)
NPK	WCP	1.61	39.3	1.53	42.1
	CMC	1.55	41.6	1.47	44.4
	PVA	1.56	41.2	1.48	44.0
YS	WCP	1.55	41.6	1.47	44.4
	CMC	1.35	49.1	1.27	51.9
	PVA	1.47	44.6	1.39	47.4
HA	WCP	1.52	41.6	1.44	45.5
	CMC	1.55	45.4	1.47	44.4
	PVA	1.45	42.7	1.37	48.2
SW	WCP	1.47	41.6	1.39	47.4
	CMC	1.33	49.9	1.25	52.7
	PVA	1.36	42.0	1.28	51.6
FM	WCP	1.55	44.6	1.47	44.4
	CMC	1.38	48.7	1.30	50.8
	PVA	1.54	48.0	1.46	44.8
Mean of organic	NPK	1.57	40.69	1.50	43.52
	YS	1.46	45.09	1.38	47.92
	HA	1.51	43.21	1.43	46.04
	SW	1.39	44.47	1.31	50.57
	FM	1.49	47.11	1.41	46.67
Mean of synthetic	WCP	1.54	41.72	1.46	44.78
	CMC	1.43	46.93	1.36	48.86
	PVA	1.47	43.69	1.40	47.19

YS: yeast sludge, HA: humic acid, SWE; seaweed extract, FM: filter mud, WCP: without CMC and PVA, CMC: carboxymethyl cellulose, PVA: polyvinyl alcohol

Ali (2011) added that applied soil conditioning such as CMC individually or in combined with organic source (compost + CMC) lead to decrease the bulk density and increased total porosity as compared to untreated sandy soil.

B- Dry –sieved aggregates (D.S.A):

The aggregate stability in sandy soil is reflected the activity of treatments applied and enhances the soil productivity.

Mean values of D.S.A% of different treatments applied were given in Table (4 a& b). The dry aggregates (D.S.A %) showed the most abundant fraction with1 to 0.5 mm either with organic soil conditioner applied individually or in combination with synthetic soil conditioner, such increased in weight diameter ranged from 31.2 to 45.2 for first season and ranged from 38.2 to 55.4 for second season. On the other hand, the percentages of other sizes of dry aggregates decrease as their diameters decrease, especially the aggregates those have diameters less than 0.063 mm which the lowest values were found. Thereby, the treatments of seaweed extract (SWE) had the highest increased on diameters 1- 0.5 and 0.5-0.25 mm, compared to control and other treatments , as well as, there is no differences between all organic treatments applied. Moreover, CMC as synthetic soil conditioner have the largest granular size with diameter (1 to 0.5) more than either PVA or control treatment in both seasons. Increasing aggregate size refers to decreasing soil bulk density and increasing macro pores as described with Koupai *et al.* (2008) and Ali (2011).

Furthermore, seaweed extract (SWE) fertilizers (especially the alginates) act as soil conditioners (Thivy, 1964). The alginates react with metals in the soil and form long and cross-linked polymers in the soil. These polymers improve the crumbing in the soil and swell up when they get wet, and retain moisture for a longer period. Dove *et al* (2016) added that the alginates can form cross-linked gels through ion tropic gelation. This occurs when a soluble form of alginate, usually sodium alginate, is converted to an insoluble gel through the introduction of divalent metal cations such as Ca^{2+}. This involves cooperative binding in water where interactions between the glurunic blocks of the negatively charged alginate polymer and the positively charged ions create chain to chain. This is due to the formation of junction zones between two or more chains where the cations sit within the buckled parts of the molecule, like eggs in an egg box.

Soil chemical properties

A- Soil pH

In fact that, many plants and soil life forms prefer either alkaline or acidic conditions, so the soil pH is an important consideration for farmers and graders for several reasons especially increasing the availability of nutrients in the soil (Smith *et al*., 1994).

With regard to the effect of organic soil conditioners either natural source or industrial residues on pH mean values of sandy soil after wheat and peanut harvested, data in Table (5) clear that all mean values were generally slightly decreased or no change noticeable occurred with all treatments applied especially after peanut harvested as compared to NPK treatment. The more effective treatment caused reduction in pH reading was SWE for both seasons. In addition, the same trend was observed with synthetic soil conditioner especially with CMC. This may due to the liberated of CO_2 and organic acids as a product of soil microorganisms acting and other chemical transformation on the added organic matter. Hamed *et al.* (2011) found that applied organic amendments were decreased soil pH with increasing the level of organic amendment. Also, mean values of soil pH were, generally, higher in second season as compared to first season.

Meanwhile, the interaction effect between combination of organic and synthetic soil conditioners were pronounced in Table (5).Obtained results revealed that pH values were generally decreased slightly from 8.41 to 8.01 at first season and from 8.69 to 8.59 at second season due to application of humic acids + CMC. These results are in harmony with Ali (2011) who found that the separately application of organic and synthetic soil conditioners or mixed them were slightly decreased the pH values as compared to untreated soil.

Table 4. Distribution fractions (%) of dry- sieved aggregates in the studied soil samples under different organic and synthetic soil conditioner after wheat and peanut harvested at two successive seasons.

A- Soil cultivated with wheat plant:

Organic soil conditioner	Synthetic Soil conditioner	Dry Aggregates Diameter (mm) 10-2	2-1	1-0.5	0.5-0.25	0.25-0.125	0.125-0.063	<0.063
NPK	WCP	2.53	4.76	31.2	24.7	25.3	10.4	0.29
	CMC	0.89	2.38	32.2	40.3	19.3	5.7	0.18
	PVA	1.06	3.41	33.2	35.5	16.4	10.1	0.31
YS	WCP	3.52	3.99	34.2	41.4	12.8	3.9	0.08
	CMC	0.15	0.43	35.2	56.5	6.3	1.2	0.03
	PVA	1.55	4.30	36.2	17.2	28.7	11.9	0.58
HA	WCP	0.40	2.31	37.2	31.3	18.6	9.9	0.33
	CMC	1.11	2.21	39.2	18.8	30.9	7.5	0.13
	PVA	1.87	5.08	38.2	13.2	21.0	20.1	0.57
SWE	WCP	1.00	3.31	43.2	7.4	36.5	8.5	0.22
	CMC	0.47	1.35	45.2	33.2	14.8	4.9	0.28
	PVA	0.61	1.10	44.2	36.5	12.7	4.7	0.04
FM	WCP	0.80	1.86	40.2	24.8	25.8	6.4	0.05
	CMC	0.50	1.90	42.2	30.4	17.6	7.0	0.56
	PVA	0.80	2.73	41.2	21.5	22.4	11.1	0.63
Mean of organic	NPK	1.49	3.52	32.2	33.5	20.3	8.72	0.26
	YS	1.74	2.91	35.2	38.4	15.9	5.66	0.23
	HA	1.12	3.20	38.2	21.1	23.5	12.5	0.34
	SWE	0.69	1.92	44.2	25.7	21.3	6.00	0.18
	FM	0.70	2.17	41.2	25.6	21.9	8.20	0.41
Mean of synthetic	WCP	1.65	3.25	37.4	26.0	23.8	7.84	0.19
	CMC	0.62	1.66	38.6	35.9	17.8	5.26	0.24
	PVA	1.18	3.32	38.6	24.8	20.2	11.6	0.43

B-Soil cultivated with peanut plant:

Organic soil Conditioner	Synthetic Soil conditioner	Dry Aggregates Diameter (mm) 10-2	2-1	1-0.5	0.5-0.25	0.25-0.125	0.125-0.063	<0.063
NPK	WCP	0.75	2.00	38.2	36.9	16.2	4.79	0.15
	CMC	0.58	1.87	47.4	35.5	9.0	5.52	0.17
	PVA	1.30	2.45	40.9	36.8	13.0	5.36	0.15
YS	WCP	2.74	3.11	39.6	42.4	10.0	3.07	0.06
	CMC	0.72	2.00	45.5	32.7	13.3	5.52	0.27
	PVA	0.37	1.10	43.9	35.6	16.0	3.03	0.08
HA	WCP	0.33	1.91	41.3	32.6	15.4	8.23	0.27
	CMC	0.52	1.04	48.0	32.4	14.5	3.53	0.06
	PVA	0.65	1.77	43.0	34.1	13.2	7.00	0.20
SWE	WCP	0.51	1.68	42.3	32.6	18.5	4.30	0.11
	CMC	0.45	0.81	55.4	30.5	9.40	3.45	0.03
	PVA	0.51	1.47	45.6	30.9	16.1	5.29	0.31
FM	WCP	0.51	1.19	41.7	36.0	16.5	4.10	0.03
	CMC	0.53	1.81	42.5	32.5	14.9	7.37	0.42
	PVA	0.50	1.90	43.1	29.4	17.6	7.04	0.56
Mean of organic	NPK	0.88	2.11	42.5	36.4	12.7	5.22	0.16
	YS	1.28	2.07	42.7	36.9	13.1	3.87	0.14
	HA	0.50	1.57	44.1	33.0	14.4	6.25	0.18
	SWE	0.49	1.32	47.8	31.3	14.7	4.35	0.15
	FM	0.51	1.63	42.4	32.6	16.3	6.17	0.34
Mean of synthetic	WCP	0.97	1.98	40.6	36.1	15.3	4.90	0.12
	CMC	0.56	1.51	47.8	32.7	12.2	5.08	0.19
	PVA	0.67	1.74	43.3	33.4	15.2	5.54	0.26

YS: yeast sludge, HA: humic acid, SWE; seaweed extract, FM: filter mud, WCP: without CMC and PVA, CMC: carboxymethyl cellulose, PVA: polyvinyl alcohol

B- Electrical conductivity (EC)

Electrical conductivity is a soil parameter that indicates indirectly the total concentration of soluble salts and is a direct measurement of salinity.

Data presented in Table (5) showed the effect of applied different sources of organic soil conditioners separately or in combination with synthetic conditioner on concentration of salt in the soil (EC)

With respect to the separately application of organic soil conditioners obtained results reveal that all mean values of EC were none significantly decreased with all treatments applied as compared to control treatment (NPK). The same trend was observed with CMC and PVA compared to without synthetic conditioners addition. Such declined in soil EC may be due to the ability of synthetic soil conditioner (hydrogels) to absorb and conserve a great deal of water and physiological solutions in themselves. Great amount of water causes a decrement in the concentration of salt and it leads to electrical conductivity reduction (Ramezani *et al*., 2005) and (Dorraji *et al.*, 2010).

C- Organic matter (OM)

Data presented in Table (5) indicated that using of different organic amendments (yeast waste, humic acids, seaweed extract or filter mud) were generally increased soil organic matter content compared to NPK treatment in both studied seasons. The increases values of OM in sandy soil noticed markedly when CMC applied in combination with organic amendments especially at seaweed treatment. Such increases may be due to applied of organic residue was enhanced the soil organic carbon and accelerated the microbial activities (Dotaniya *et al*., 2013d).

Table 5. Effect of different organic and synthetic soil conditioners on some chemical properties and nutrients availability in sandy soil after wheat and peanut harvested

Organic soil conditioners	Synthetic Soil conditioners	Wheat						Peanut					
		pH (1:2.5)	EC dSm^{-1}	OM %	mg kg^{-1}			pH (1:2.5)	EC dSm^{-1}	OM %	mg kg^{-1}		
					N	P	K				N	P	K
NPK	WCP	8.41	0.35	0.55	112	14.2	78.7	8.69	0.63	0.50	146	26.6	41.0
	CMC	8.06	0.32	0.61	127	20.8	103.4	8.49	0.48	0.60	165	33.6	56.0
	PVA	8.21	0.35	0.73	119	17.3	93.6	8.59	0.53	0.58	155	27.8	57.2
YS	WCP	8.29	0.38	0.71	149	18.1	112.5	8.69	0.51	0.65	291	28.4	70.9
	CMC	8.04	0.36	1.26	224	22.7	155.4	8.49	0.42	0.76	194	47.9	96.9
	PVA	8.24	0.37	0.87	187	18.5	119.0	8.69	0.43	0.74	197	44.6	80.6
HA	WCP	8.27	0.36	0.96	149	11.9	101.4	8.69	0.48	0.71	179	27.5	60.5
	CMC	8.01	0.33	1.25	164	27.3	101.4	8.59	0.44	0.61	194	44.3	109.9
	PVA	8.22	0.35	1.08	149	15.1	130.0	8.69	0.48	0.71	194	34.5	66.3
SWE	WCP	8.28	0.34	0.56	112	23.7	105.3	8.59	0.43	0.84	226	42.1	85.8
	CMC	8.06	0.35	1.80	224	29.8	174.6	8.49	0.38	1.01	291	54.1	120.7
	PVA	8.07	0.34	1.05	149	24.7	118.3	8.59	0.39	0.96	146	33.5	99.5
FM	WCP	8.3	0.35	0.84	149	12.9	106.0	8.69	0.49	0.85	194	28.6	50.1
	CMC	8.02	0.34	1.49	187	29.5	171.2	8.59	0.49	0.91	243	39.6	117.0
	PVA	8.23	0.35	1.30	149	16.8	104.0	8.59	0.49	0.88	194	35.8	85.0
Mean of organic	NPK	8.23	0.34	0.63	119	17.4	91.9	8.59	0.55	0.56	155	29.4	51.4
	YS	8.19	0.37	0.95	187	19.8	128.9	8.62	0.45	0.72	227	40.3	82.8
	HA	8.17	0.35	1.10	154	18.1	110.9	8.66	0.47	0.67	189	35.4	78.9
	SWE	8.14	0.34	1.14	162	26.1	131.7	8.56	0.40	0.94	221	43.2	102.0
	FM	8.18	0.35	1.21	162	19.8	128.1	8.62	0.49	0.88	210	34.7	84.0
Mean of synthetic	WCP	8.31	0.36	0.72	134	16.1	100.8	8.67	0.51	0.71	207	30.6	61.6
	CMC	8.04	0.34	1.28	185	26.0	141.2	8.53	0.44	0.78	217	43.9	100.1
	PVA	8.19	0.35	1.01	151	18.5	113.0	8.63	0.46	0.78	177	35.2	77.7
LSD at 0.05%													
A (organic		0.13	0.007	0.17	4.81	1.72	9.89	0.12	0.02	0.07	29.9	5.55	6.44
B (synthetic)		0.10	0.006	0.13	3.73	1.33	7.66	0.10	0.02	0.05	23.2	4.30	4.99
A*B		0.22	0.013	0.30	8.34	2.97	17.1	0.22	0.04	0.12	51.9	9.62	11.2

YS: yeast sludge, HA: humic acid, SWE; seaweed extract, FM: filter mud, WCP: without CMC and PVA, CMC: carboxymethyl cellulose, PVA: polyvinyl alcohol

D- Macronutrients availability

Concerning the availability of soil nutrients N, P and K were presented in Table (5). Obtained results reflect the positive relation between treatments applied and the amount of nutrients able to be used by plant. Mean values of available N, P and K in soil were significantly increased under organic treatments application particularly with SWE which overtook other treatments. This increase may be due to the presence of carboxylates group which have direct effect on nutrients released in soil (Datta and Gupta, 1983a) and a range of organic acids are produced during the organic residues decomposition (Dotaniya and Meena, 2013) which mobilize the nutrients from fixed sites and are easily available to plants (Dotaniya *et al*., 2013a, b).

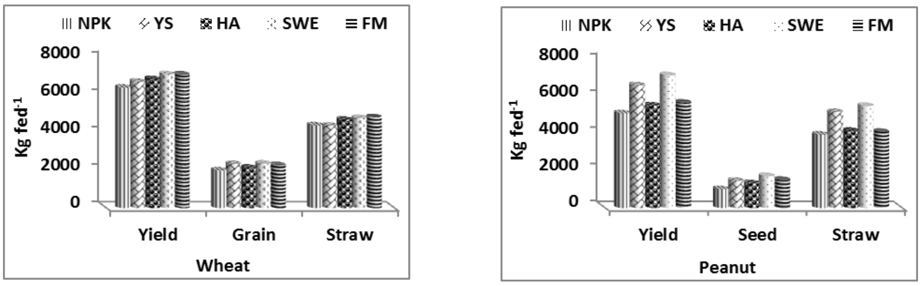
Also, mean values of synthetic soil conditioners reveal that CMC was superior for N, P and K availability in soil as compared to either PVA or control (without synthetic soil conditioners) treatment.

The interaction between applied of different organic soil conditioners in parallel with synthetic soil conditioners gave the highest response especially with SWE + CMC more than other treatments. Obtained data agree with Kumar *et al*. (2018) who reported that application of plant residues as organic soil conditioner and synthetic soil conditioner was significantly influenced available N, P and K content in soil.

Yield and yield components:

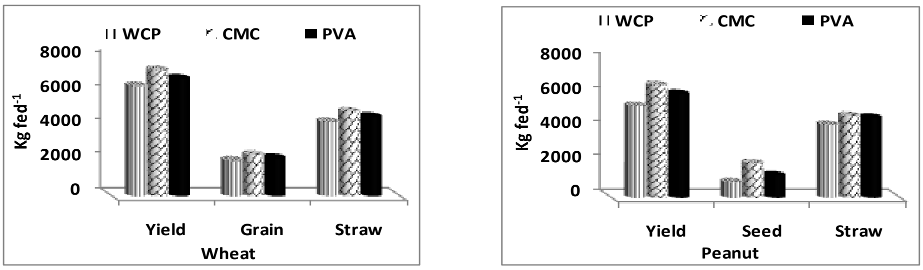
Regarding the effect of different organic soil conditioners on wheat and peanut yield components (Biological yield, straw yield and/or seed yield) data in Fig (1a) show that all mean values of growth parameters were generally increased significantly by applying YS, HA, SW and FM as compared NPK treatment. The maximum value was obtained with seaweed extract followed by filter mud treatment. Such increases reach about 17.9 % and 70.0% for grain or seed while reach to 8.6% and 39.1% for straw in wheat and peanut, respectively. Our findings coincide with those of earlier studies carried out on soybean with Rathore *et al*. (2009) they reported that the application of seaweed extract lead to increase in vegetative plant growth because it very rich in gibberellic acid, which activate amylase genes in aleurone cell acts to produce a signal in the germinating process of seeds (Sun and Gubler, 2004). In addition, seaweeds can be stimulate the growth and yield of plants because it contains essential fatty acids, vitamins, amino acids, minerals, and growth promoting substances as well as enhance antioxidant properties, and develop tolerance to drought stress (Spann and Little, 2011). Also, FM was liberated different types of organic acids during microbial decomposition lead to increase plant productivity and nutrient contents (Bhattacharyya *et al*., 2003).

With respect to the main effect of synthetic soil conditioners, result show that either CMC or PVA increased significantly wheat and peanut plant productivity (biological yield, grain/seeds and straw) as compared to control (zero addition). Moreover, CMC application was superior to PVA on yield parameters, where it increased grain or seed by 15.9% and 119% as well as increased straw by 13.8% and 12.5% for wheat and peanut plant, respectively. In addition, hydrogels (CMC or PVA) help to reduce water stress of plants resulting in increased growth and plant performance (El-Hady *et al*., 1981). Also, Sivapalan (2001) added that the germination process, plant growth, nutrients uptake, yield and both the water and fertilizer use efficiency were beneficially increased by mixing the plant pits in sandy soil with hydrogels (El-Hady *et al*., 2002 and Akelah, 2013).



A

LSD at 0.05%: yield= 178.6 straw= 167 grain= 68.8 yield= 148 straw= 128.4 grain= 76.5



B

LSD at 0.05%: yield= 124 straw= 129.7 grain= 55.9 yield= 102 straw= 105.2 grain= 50

Fig. 1. Mean values of yield components of both wheat and peanut as affected by different organic and synthetic soil conditioners

The interaction effect of applying organic soil conditioner in combination with synthetic soil conditioner was representing in Table (6). It is interested to mention that, the efficiency of organic soil conditioner was increased with synthetic soil conditioner applied. The pronounced increase in crop productivity (yield, grain/seeds and seed) was observed when seaweed was combined with CMC treatment as compared to other treatment over to NPK (control). These results are in harmony with Kalhapure *et al.* (2016) who found that application of 5 kg/ha of hydrogel produced significantly increased in grain yield of wheat by 8.48% over control. Moreover El Hady *et al.* (2012) added that the application of different rates of hydrogel in combination with compost as organic soil conditioner led to increasing tomato yield per unit and wheat plant (EL-Naka *et al*., 2015)

Table 6. Interaction effect of different organic and synthetic soil conditioners on yield components of wheat and peanut crops

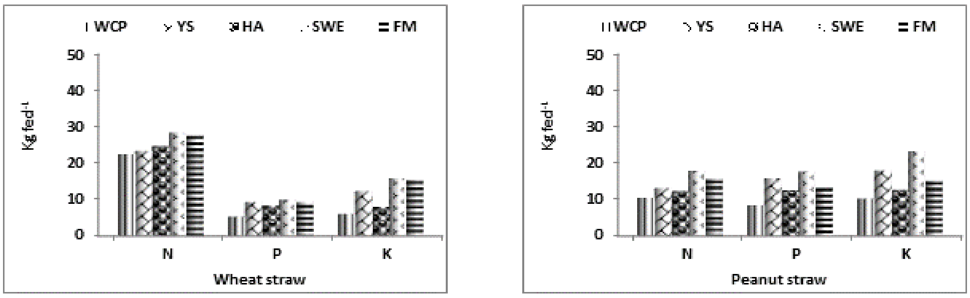
Organic soil Conditioners	Synthetic Soil conditioners	Wheat			Peanut		
		Kg fed^{-1}					
		Biological yield	Grain	Straw	B. Yield	Straw	Seed
NPK	WCP	6231	1867	4364	4690	3845	669
	CMC	6664	2176	4488	5477	4043	1326
	PVA	6352	1984	4368	5166	3992	1051
YS	WCP	5888	2179	3709	5782	4568	959
	CMC	7632	2556	5076	7308	5486	2030
	PVA	6656	2308	4348	6767	5484	1404
HA	WCP	6720	2046	4674	4750	3771	1021
	CMC	7056	2213	4843	6146	4501	1613
	PVA	6804	2208	4596	5695	4236	1360
SWE	WCP	6680	2217	4463	6699	5349	1205
	CMC	7765	2567	5199	7581	5532	2542
	PVA	6912	2327	4585	7207	5644	1432
FM	WCP	6424	2068	4356	4984	3808	706
	CMC	7472	2520	4952	6488	4454	2521
	PVA	7433	2260	5173	5565	4057	1308
LSD at 0.05%		277.4	290	125.0	228	235.2	111.9

YS: yeast sludge, HA: humic acid, SWE; seaweed extract, FM: filter mud, WCP: without CMC and PVA, CMC: carboxymethyl cellulose, PVA: polyvinyl alcohol

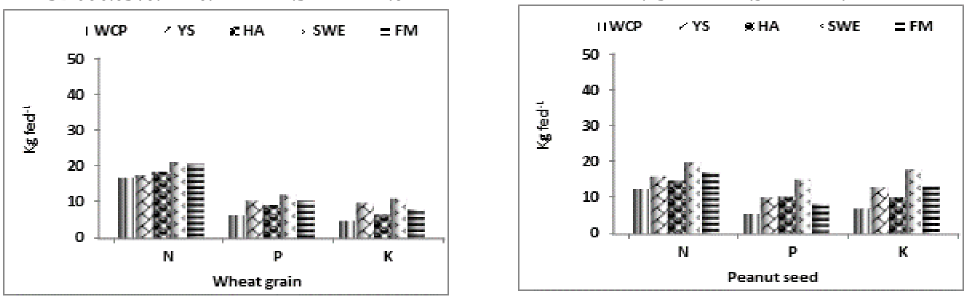
Macronutrients total content in both wheat and peanut crops

Concerning the effect of organic soil conditioner application data in Fig (2) generally show that N, P and K total content were significantly increase in both straw and grains and/or seeds of wheat and peanut crops as compared to NPK control treatment. The superior one is seaweed treatment followed by filter mud, yeast waste and humic acid. Such increase may be due to increment of seaweeds with nutrients content and lead to compensate the deficiency of N, P and K in soils (Singh *et al*., 2016; Vyomendra and kumar, 2016). Also, Nędzarek and Rakusa-Suszczewski (2004) added that a mixture of macroalgae released high quantities of organic matter and different nutrients, especially very rich in NH_4^-, NO_3^- and NO_2^-, and phosphate.

Recently, Shehata *et al.* (2011) and Eisa (2016) found that the percentages of N, P and K in leaves of sweet fennel and celeriac plant were increased significantly with foliar application of seaweed extract. The highest respect values of macronutrients (N, P and K) might be attributed to organic and mineral elements constituents of seaweed extract.



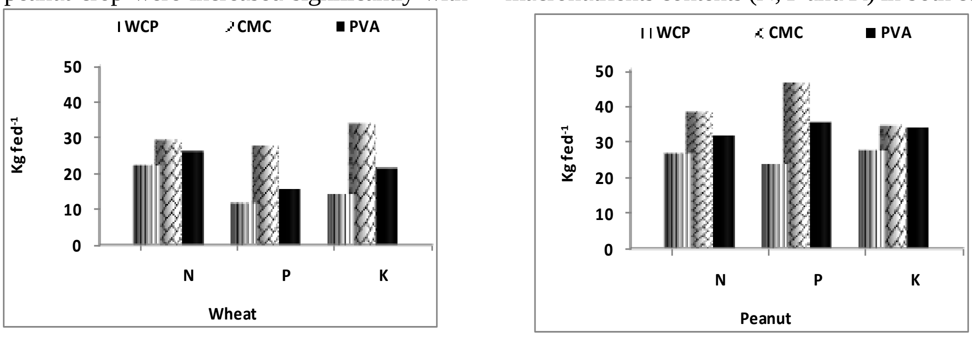
LSD at 0.05%: N= 0.47 P= 2.54 K= 1.62 **N=2.25 P= 1.97 K=1.21**



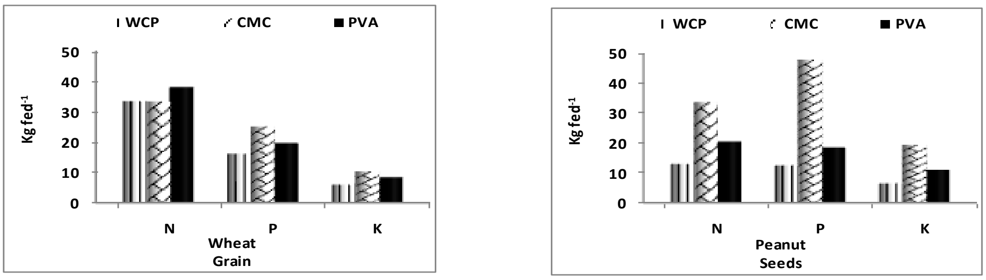
LSD at 0.05%: N= 3.86 P= 1.41 K= 0.31 **N=3.45 P=5.61 K=1.34**

Fig. 2. Mean values of macronutrients total content of both wheat and peanut as affected by different organic soil conditioners

With respect to the application of synthetic soil conditioners data in Fig (3) reveal that mean values of macronutrient total contents in straw and grains and/or seeds of wheat and peanut crop were increased significantly with two tested polymers applied as compared to control (zero addition). Result, also, showed that applied CMC to sandy soil gives the maximum straw, grains and/or seeds macronutrients contents (N, P and K) in both cultivated crop.



LSD at 0.05%: N=0.29 P= 1.37 K=0.93 **N= 1.41 P= 1.49 K=1.47**



LSD at 0.05%: N= 2.58 P=0.88 K=0.28 **N= 2.45 P= 3.85 K=0.96**

Fig. 3. Mean values of macronutrients total content of both wheat and peanut as affected by synthetic soil conditioners

Obtained data agree with Ziaeidoustan *et al*. (2013) and Abobatta (2018) who mentioned that hydrogel polymers caused an increase in nutrient (NPK) uptake because it can stored enough amount of available water helped the plant to overcome the severe drought. On the other hand, it helped the N fixation bacteria to gain their needed moisture and nodulation which helped to uptake the soil nitrogen and increased the yield.

Moreover, the interaction effects of combination organic and synthetic soil conditioners data in Table (7) showed that the application of different organic materials with CMC or PVA was give high significant values over control. Also, the macronutrients total contents were increased significantly with CMC more than PVA at the same condition. Such increases may be due to decreasing nutrient leaching in the presence of the hydrogel whereas; free pore volume will be created within the soil, offering additional space for root growth, air and water infiltration and storage. Stockosorb also strongly resists soil pressure at high soil depth without losing its swelling capacity. In this way water and nutrients are available to the plant over a longer period of time (Pattanaaik *et al*., 2015).

Table 7. Interaction effect of different organic and synthetic soil conditioners on macronutrients total content in straw, grain and /or seed of wheat and peanut crops

Organic soil Conditioners	Synthetic Soil conditioners	Wheat						Peanut					
		Kg fed^{-1}											
		Straw			Grain			Straw			Seed		
		N	P	K	N	P	K	N	P	K	N	P	K
NPK	WCP	21.3	5.0	4.8	16.0	5.1	3.7	9.1	8.0	10.3	10.9	2.7	4.1
	CMC	24.0	6.0	5.9	18.0	7.9	6.0	13.3	9.0	11.0	16.0	8.1	10.5
	PVA	22.4	5.7	8.1	16.8	6.7	5.4	9.4	8.8	10.0	11.3	6.4	7.0
YS	WCP	19.9	5.5	5.4	14.9	7.9	7.0	10.5	12.9	15.4	12.8	6.9	7.8
	CMC	26.8	15.1	22.0	20.1	13.3	12.3	15.4	15.5	17.2	18.5	15.1	21.1
	PVA	23.8	7.8	10.2	17.8	10.4	10.7	14.0	19.6	21.7	16.8	8.6	10.4
HA	WCP	21.8	6.6	7.4	16.4	7.3	5.6	10.1	8.4	9.8	12.1	3.6	5.5
	CMC	28.2	11.2	9.2	21.2	11.2	8.6	15.1	10.1	14.3	18.1	16.6	14.4
	PVA	24.3	7.6	8.1	18.2	9.8	6.2	12.3	19.6	14.3	14.7	11.1	10.8
SWE	WCP	25.0	7.2	10.2	18.8	10.9	6.1	11.3	15.3	20.9	16.1	12.0	8.3
	CMC	32.1	14.3	25.8	24.1	13.6	15.6	22.1	19.8	26.2	22.2	21.6	29.6
	PVA	28.2	8.9	11.9	21.2	12.1	11.7	20.7	18.4	23.0	21.6	12.1	15.8
FM	WCP	23.7	5.2	8.2	17.8	9.5	7.5	10.7	10.1	12.5	12.6	6.2	6.4
	CMC	30.0	13.9	22.5	22.6	11.9	9.2	20.3	17.4	17.7	19.8	10.7	21.9
	PVA	28.9	9.4	15.9	21.7	10.4	7.8	16.3	12.4	15.8	19.1	8.4	11.4
LSD at 0.05%;-		0.64	3.07	2.07	4.47	1.96	0.63	3.14	3.32	3.29	4.97	8.61	2.14

YS: yeast sludge, HA: humic acid, SWE; seaweed extract, FM: filter mud, WCP: without CMC and PVA, CMC: carboxymethyl cellulose, PVA: polyvinyl alcohol

Correlation between yield (grains and/or seeds) and soil properties

This correlation analysis is presented in Table (8). A significant high- magnitude positive correlation was establish between grain yield of wheat crops and EC (r=0.55), OM (r= 0.69), available P (r = 0.73), available K (r = 0.83), available N (r = 0.8) and total porosity (r = 0.77). Also, a significant high positive correlation was also between seed yield of peanut crops and EC (r = 0.63), OM (r = 0.51), P (r = 0.68), K (r = 0.86), N (r = 0.41) and total porosity (r = 0.77).

Table 8. Correlation coefficients among grain and/or seed of wheat and peanut plants and tested soil parameters

A- Wheat plant								
	Grain	**pH**	**EC**	**OM**	**Available P**	**Available K**	**Available N**	**Total porosity**
Grain	1							
pH	-0.016	1						
EC	0.55*	0.12	1					
OM	0.69*	-0.20	0.48*	1				
Available P	0.73*	-0.097	0.72*	0.54*	1			
Available K	0.83*	0.016	0.44*	0.695	0.599*	1		
Available N	0.796*	-0.17	0.35	0.76*	0.48*	0.80	1	
Total porosity	0.77*	-0.27	0.34*	0.73*	0.53*	0.70	0.78*	1

B- Peanut plant								
	Seed	pH	EC	OM	Available P	Available K	Available N	Total porosity
Seed	1							
pH	0.15	1						
EC	0.63*	-0.09	1					
OM	0.51*	0.24	0.72*	1				
Available P	0.68*	0.21	0.53*	0.40*	1			
Available K	0.86*	0.19	0.66*	0.58*	0.67*	1		
Available N	0.41*	-0.15	0.35*	0.296*	0.35*	0.41*	1	
Total porosity	0.78*	0.34*	0.62*	0.66*	0.55*	0.69*	0.22	1

Levels of significant: * P> 0.05

These result indicated that if the yield decreased or increased, the wheat grain or peanut seed and soil tested measured (EC, OM, P, K, N and porosity) in soil decreased or increased.

Moreover, a significant positive correlation was noted between EC after wheat crop harvested and OM content (r = 0.48) and available P (r = 0.72), available K (r =0.44) and total porosity (r = 34). A long with such correlation of peanut seeds was noted between EC and OM (r = 0.72), P (r = 0.53), K (r = 0.66), N (r = 0.35) and total porosity (r = 0.62).

With the same pattern, OM content in soil cultivated with wheat crop was high positive correlation between P (r = 0.54), K (r = 0.7), N (r = 0.76) and total porosity (r = 0.73), as well as, in soil cultivated with peanut crop OM had high positive correlation between P (r = 0.4), K (r= 0.58), N (r= 0.3) and porosity (r = 0.66).

Also, available macronutrients content were high significantly correlated in soil either cultivated with wheat or peanut crops. Whereas, available P was highly correlated with K (r = 0.6& r = 0.67), N (r = 0.48 & r= 0.35) and total porosity (r = 0.53 & r = 0.55) for soil cultivated with wheat and peanut, respectively.

However, available K was high significant correlation between N (r = 0.41) and total porosity (r = 0.69) for soil cultivated with peanut crop only. While available N was highly correlated with total porosity in soil cultivated with wheat crop only. These results agree with Mahmood *et al*. (2017).

CONCLUSION

In general, using of residual waste from cane industries or humic acid and seaweed as organic soil conditioner individually or in combination with CMC or PVA were enhanced both plant growth and their total macronutrients content, as well as, improved chemical-physical properties of sandy soil by increasing available NPK, porosity and OM% which lead to increasing dry stable aggregates whereas pH and EC values were decreased. Seaweed treatment was become more effective when added with CMC.

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التفاعل بين مصادر مختلفة من محسنات التربة العضوية مع بعض المحسنات الصناعية لتحسين خواص التربة الرملية وزيادة إنتاجيتها

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اقيمت تجربة حقليه خلال موسمين زراعيين متتاليين (2016-2017) بمحطة البحوث الزراعية بالإسماعيلية باستخدام نباتي القمح والفول السوداني لتقييم فاعلية تداخل استخدام المحسنات العضوية الطبيعية او الناتجة كمخلف من بعض الصناعات مع وجود بعض المحسنات الصناعية علي خواص التربة الرملية الفيزيائية و الكيميائية وانعكاس ذلك علي الحالة الغذائية والانتاجية للنبات. صممت التجربة في قطع منشقة مرة واحدة في ثلاث مكررات وقد تضمنت التجربة خمس معاملات عضوية كعامل رئيسي وهي (كنترول - المعدل الموصي به من التسميد المعدني) , مخلف الخميرة بمعدل 2 كجم/فدان- هيوميك اسيد تجاري بمعدل 1 كجم/فدان - طحالب بحرية بمعدل 100جم/فدان- طينة مرشحات بمعدل 5 كجم/فدان. بينما تضمنت المعاملة الفرعية ثلاث محسنات صناعية وهي (الكنترول (بدون اضافة) - الكربوكسي ميثيل سليلوز بمعدل 2% - البولي فينيل الكحول بمعدل 0.2 %). واظهرت النتائج ان تداخل استخدام المحسنات العضوية في وجود المحسنات الصناعية كان له تأثير ايجابي علي خواص التربة الطبيعية حيث أدي الي انخفاض قيم الكثافة الظاهرية وزيادة كل من المسامية والتجمعات الارضية وكانت اعلي القيم المتحصل عليها عند اضافة الطحالب البحرية في وجود الكربوكسي مثيل سليلوز . وبصفة عامة لا يوجد فرق معنوي بين استخدام الطحالب البحرية وغيرها من المخلفات العضوية حيث اعطي استخدام مخلف الخميرة وطينة المرشحات نفس الاتجاه مقارنة بالكنترول. بالاضافة الي ذلك فان محتوي التربة من المادة العضوية والعناصر الكبري الميسرة قد زادت مع كل المعاملات المضافة مقارنة بالكنترول وسجلت اعلي قيمة تحت معاملة الطحالب البحرية في وجود الكربوكسي ميثيل سليلوز. بينما أعطت قيم الأس الهيدروجيني والتوصيل الكهربي اتجاه معاكس حيث انخفضت كل القيم المتحصل عليها لكلا العاملين انخفاضا غير معنويا مع كل المعاملات المضافة وخاصة في وجود الطحالب البحرية مع الكربوكسي ميثيل سليلوز. كما اشارت النتائج أن استخدام الطحالب البحرية منفردة او مقترنة باضافة الكربوكسي مثيل سليلوز او البولي فينيل الكحول أدي الي زيادة معنوية لكل من المحصول البيولوجي, الحبوب أو البذور بالاضافة الي المحتوي الكلي من النيتروجين و الفسفور و البوتاسيوم لنباتي القمح والفول السوداني مقارنة بالكنترول. بالاضافة الي ذلك أوضحت النتائج وجود ارتباط عالي المعنوية ($P<0.05$) بين محصول الحبوب و كل من التوصيل الكهربي, المادة العضوية و النيتروجين الميسر و الفوسفور الميسر في التربة علي الرغم من عدم وجود ارتباط معنوي بين محصول الحبوب ودرجة الأس الهيدروجيني و البوتاسيوم الميسر. أخيراً يمكن استنتاج ان استخدام المحسنات العضوية خاصة الطحالب البحرية والمخلفات الناتجة من تصنيع قصب السكر ادي الي تحسين خواص التربة الكيميائية والطبيعية وزيادة قدرتها الانتاجية عند استخدامها مع المحسنات الصناعية وخاصة الكربوكسي ميثيل سليلوز.