

Physico-Chemical Behavior of Natural Minerals along with Synthetic Soil Conditioners on Nutritional Status and Yield Productivity

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ABSTRACT

A field experiment was carried out for two successive seasons (summer season 2017 and winter season 2017/2018) on sandy soil at Ismailia Agric. Res. Station, Ismailia Governorate, Egypt (Latitude, 30°35' 41.901" N and longitude, 32°16' 45.834" E) cultivated with sesame and wheat crops respectively, to highlight the effect of applying natural minerals and synthetic soil conditioners alone or in combination on some sandy soil properties and productivity of sesame and wheat crops. Three natural clay minerals (bentonite, vermiculite and zeolite) were added at the rate of 2 ton fed⁻¹. Alone or in combination with three synthetic soil conditioners; hydrogel (HG), polyvinyl alcohol (PVA) and anionic polyacrylamide (PAM) which were added at the rate of 6 Kg fed⁻¹. Results indicated that application of natural minerals and synthetic soil conditioners alone or in combination increased significantly values of soil moisture characteristics (field capacity (FC), wilting point (WP), available water (AW), total porosity (TP)), soil nutrients availability (N, P and K), yield components and total content of macronutrients (N, P and K) in straw, seeds and grains of sesame and wheat. Bentonite being superior as compared to other clay minerals for increasing (FC), (WP), (AW), (TP), EC values, soil nutrients availability (N, P and K), yield components and total content of macronutrients (N, P and K) in straw, seeds and grains of sesame and wheat followed by vermiculite and zeolite while values of soil reaction decreased slightly as compared to control. As for the effect of synthetic soil conditioners, application of synthetic soil conditioners significantly increased total porosity (TP), field capacity (FC), wilting point (WP), available water (AW), EC values, soil nutrients availability (N, P and K), yield components and total content of macronutrients (N, P and K) in straw, seeds and grains of sesame and wheat while pH values decreased as compared to control especially in presence of hydrogel combined with bentonite. Bentonite combined with hydrogel recorded the highest values of soil moisture characteristics (FC, WP and AW), TP, EC values, soil nutrients availability (N, P and K), yield components and total content of macronutrients (N, P and K) in straw, seeds and grains of sesame and wheat. While the inferior treatment values were zeolite combined with polyvinyl alcohol (PVA).

Keywords: Physical, chemical, clay minerals, synthetic conditioners, yield, sesame, wheat.

INTRODUCTION

Natural and synthesized soil conditioners improve some sandy soils properties and their productivity (Arafat and El-Hady 2002).

In this concern, Sallam *et al.* (1995) concluded that mixing bentonite with sandy soil improved the soil moisture characteristics and cation exchange capacity. Tawfiq (2009) mentioned that bentonite is natural clay minerals with high cation exchange capacity (CEC) and ion adsorption capacity; applied natural soil conditioners such as bentonite improve the sandy soil fertility, growth, yield and chemical composition of plants.

At the same time, bentonite increased the nutrients content, the colloid content of soil and decreased leaching of nutrients (Sithaphanit *et al.* 2010). Also, Iskander *et al.* (2011) showed that bentonite could raise the storage capacities of soil for water and fertilizer. Besides, bentonite reduced soil fixation for phosphorus and potassium and increase yield productivity of potato (Jena and Kabi, 2012).

Vermiculites are present in soil fractions ranging from fine clay through coarse sand. Vermiculite has a very high cation exchange capacity and hence, other exchangeable cations may supply a ryegrass plant with macronutrients. Also, vermiculite has a very high water absorbing capacity than other minerals thus increasing available soil moisture, and this will affect positively dry matter production, (Seddik 2001).

Zeolite is naturally clay mineral have high cation exchange and ion adsorption capacity (Mumpton, 1999). Furthermore, Erdem *et al.* (2004) mentioned that zeolite hold high potential for the sorption of several cations. Moreover, Ramesh and Reddy (2011) mentioned that zeolites have high porosity, cation-exchange capacity (CEC) and incorporation zeolite in the soil led to increase in crop yields and enhance nutrient use efficiency.

Zeolite addition improves soil conditions in arid and semi-arid soil. Noori *et al.* (2007) reported that adding zeolite

improves soil properties, suitable carriers for fertilizers and increases crop yield productivity. Also, Sheta *et al.* (2003) mentioned that zeolite and bentonite have a high potential for nutrient retention. Moreover, Bernardi *et al.* (2010) found that zeolite enriched with N, P and K with lettuce, tomato and rice, act as a slow-release nutrient source for plants and increased significantly fresh and dry weight of them.

Synthetic polymers play an important role in agricultural by enhancing plant growth especially for sandy soils, which have a low content of organic matter, low retention capacity of water and nutrients due to the excessive deep percolations losses, which consequently reduce the use efficiency of water and fertilizer (Ekebafe *et al.* ,2011). A synthetic polymer such as a hydrogel, polyvinyl acetate, polyvinyl alcohol and polyacrylamide have been recommended to evaluate their impact on improving physical and chemical characteristic of soil and increasing crop yields productivity.

The hydrogels are improving plant-soil water relations in sandy soil, as compared to bentonit and farmyard manure (Moustafa *et al.*, 1995). Also, Buchholz and Graham (1997) reported that superabsorbent polymers are compounds that absorb water and swell to many times their original size and weight. They are lightly cross-linked networks of hydrophilic polymer chains. Wu *et al.* (2008) reported that hydrogels act as a controlled release system by enhancing the uptake of some nutrients, resulting in improved growth.. Moreover, Dabhi *et al.* (2013) mentioned that super absorbent polymers are safe, biodegradable, non- toxic and inert with increased self-life, super absorbent polymers could be improving irrigation efficiency.

Nazarli *et al.* (2010) reported that the application of polymer has a beneficial effect on all characteristics of the plants in all levels of water stress treatments and suggests that it is reduced 15 to 50 % of total water irrigation requirement.

The presence of soil conditioners especially for polyvinyl alcohol (PVA) decreased the values of pH and

increase EC.; high concentration of polyvinyl alcohol under 75 % from the irrigation requirements was superior for both peanut and sesame crops (Eletr and Osman, 2014). Moreover, Galeş *et al.* (2016) found that applying the aquasorb hydrogel had a direct influence on increasing the bulk density, soil moisture, and soil water reserve and decrease the total porosity. Also, polyacrylamide is one of the most widely employed soil conditioners. Application of polyacrylamide to soils at a rate of 5 to 10 g kg⁻¹ reduced water infiltration by 87 to 94% relative to control. Polymers have a good effect in improving the physico-chemical properties of soils (Lentz, 2007).

The present work aims to investigate the effect of applying natural clay minerals and synthetic soil conditioners alone or in combined on some sandy soil properties and its productivity.

MATERIALS AND METHODS

A field experiment was carried out at Ismailia Agric. Res. Sta. ARC during summer season (2017) with sesame (*Sesamum indicum* L. var., Giza 32) and winter season (2017/2018) with wheat (*Triticumaestivum* L., CV. Giza 168) cultivated on sandy soil under drip irrigation system to evaluate physico-chemical behavior of natural clay mineral along with synthetic soil conditioners application alone or in combination on nutritional status and yield productivity of sesame and wheat crops. The soil under study was analyzed according to Cottenie *et al.*, (1982) as shown in Table (1), natural minerals (Bentonite, vermiculite and zeolite) constituents were described in Table (2).

Table 1. Some physical and chemical properties of the experimental soil

Soil characteristics	Values	Soil characteristics	Values
Particle size distribution (%)		Soluble cations and anions (meq/l)	
Coarse Sand	50.20	Ca ⁺⁺	0.82
Fine Sand	40.60	Mg ⁺⁺	0.74
Silt	3.20	Na ⁺	1.22
Clay	6.00	K ⁺	0.34
Texture class	Sandy	CO ₃ ⁻	-
		HCO ₃ ⁻	1.22
		Cl ⁻	0.94
Chemical properties		SO ₄ ⁻	0.96
CaCO ₃ %	1.40	Available nutrients (ppm)	
pH(Suspension 1: 2.5)	7.92	N	74.00
EC dS/m (saturated paste extract)	0.32	P	9.00
Organic matter (%)	0.40	K	50.00

Table 2. Some chemical properties of natural clay minerals (bentonite, vermiculite and zeolite) used in the experiment.

Characteristics	Bentonite	Vermiculite	Zeolite
pH	8.01	7.45	6.90
EC (dSm ⁻¹)	3.77	0.44	0.07
CEC	64.0	52.00	45.00
	Available macronutrients (ppm)		
N	13.0	11.60	0.00
P	2.10	3.50	0.03
K	151.00	76.10	300.00

The experiment was designed in completely randomized design with three replications. Three natural clay minerals (bentonite, vermiculite and zeolite) were added at the rate of 2 ton fed⁻¹ alone or in combination with three

synthetic soil conditioners forms, hydrogel (HG), polyvinyl alcohol (PVA) and anionic polyacrylamide (PAM) which were added at the rate of 6 Kg fed⁻¹. All treatments of soil conditioners were added to soil surface before cultivation alone or in combination with three synthetic soil conditioners forms. The formulation of the used soil conditioners were hydrogel, with pH near natural, PVA (C₂H₃O)_n, with pH of 5.0-6.5 and PAM(C₃H₅NO)_n with pH of 4-9.

All treatments received mineral fertilizers as ammonium sulphate (20.6 % N), super phosphate (15 % P₂O₅) and potassium sulphate (48% K₂O) as recommended dose for sesame and wheat production.

At maturity, sesame and wheat were harvested to determine yield components (seeds or grains and straw) and nutrient status. Plant samples were oven-dried at 70 C° for 48 hours, up to constant dry weight, ground and digested using of sulfuric acid and hydrogen peroxide mixture as described by Page *et al.* (1982). Soil chemical properties along with analyses for natural minerals were evaluated according to Cottenie *et al.* (1982). Obtained results were subjected to statistical analysis according to Snedecor and Cochran (1982), the treatments were compared by using the Least Significant Difference (L.S.D) at 0.05 level of probability.

RESULTS AND DISCUSSION

Effect of applying natural clay minerals and synthetic soil conditioners alone or in combination on some soil physical, chemical properties and its productivity.

A-physical properties:

Results presented in Fig. (1) indicated that natural clay minerals and synthetic soil conditioners amendments alone or in combination increased significantly field capacity (FC), wilting point (WP), available water (AW) values and total porosity (TP) as compared to control treatment.

Concerning the effect of natural clay minerals (bentonite, vermiculite and zeolite) for both studied seasons, the application of natural minerals significantly increased Field capacity (FC), wilting point (WP), available water (AW) and total porosity (TP), values of the studied soil as compared to control. Bentonite, being superior as compared to other clay minerals. This may be due to its positive effect on water holding capacity. Treatments of natural minerals arranged as follows: bentonite > vermiculite > zeolite for both seasons. These results agree with those of Iskander *et al.* (2011) who found that bentonite could raise the storage capacities of soil for water and fertilizer. The same trend was found by Hassan and Mahmoud (2013) who revealed that the application of bentonite and zeolite increased Field capacity (FC), available water and total porosity (TP).

As for the effect of synthetic soil conditioners Hydrogel (HG), anionic polyacrylamide (PAM) and polyvinyl alcohol (PVA), data indicated that, for both seasons, the addition of synthetic soil conditioners significantly increased FC, WP, AW and TP values as compared to control. Treatments of synthetic soil conditioners arranged as follows: Hydrogel (HG) > polyacrylamide (PAM) > polyvinyl alcohol (PVA). Hydrogel application may stabilize the soil structure, increase the erosion resistance and the infiltration rate and may decrease the surface drain (Jihoon *et al.*,2015).These results are similar to those of Gales *et al.* (2016) who showed that applying the Aquasorb hydrogel increased soil moisture and soil water reserve.

The interaction effect showed that values of (FC), (WP), (AW) and (TP) at the two studied seasons were most positively affected by application of natural minerals in presence of synthetic soil conditioners. The highest values of TP and soil moisture were obtained with the application of

bentonite combined with hydrogel followed by bentonite combined with polyacrylamide and vermiculite combined with polyacrylamide. On the other hand, the lowest values were observed with zeolite combined with polyvinyl alcohol.

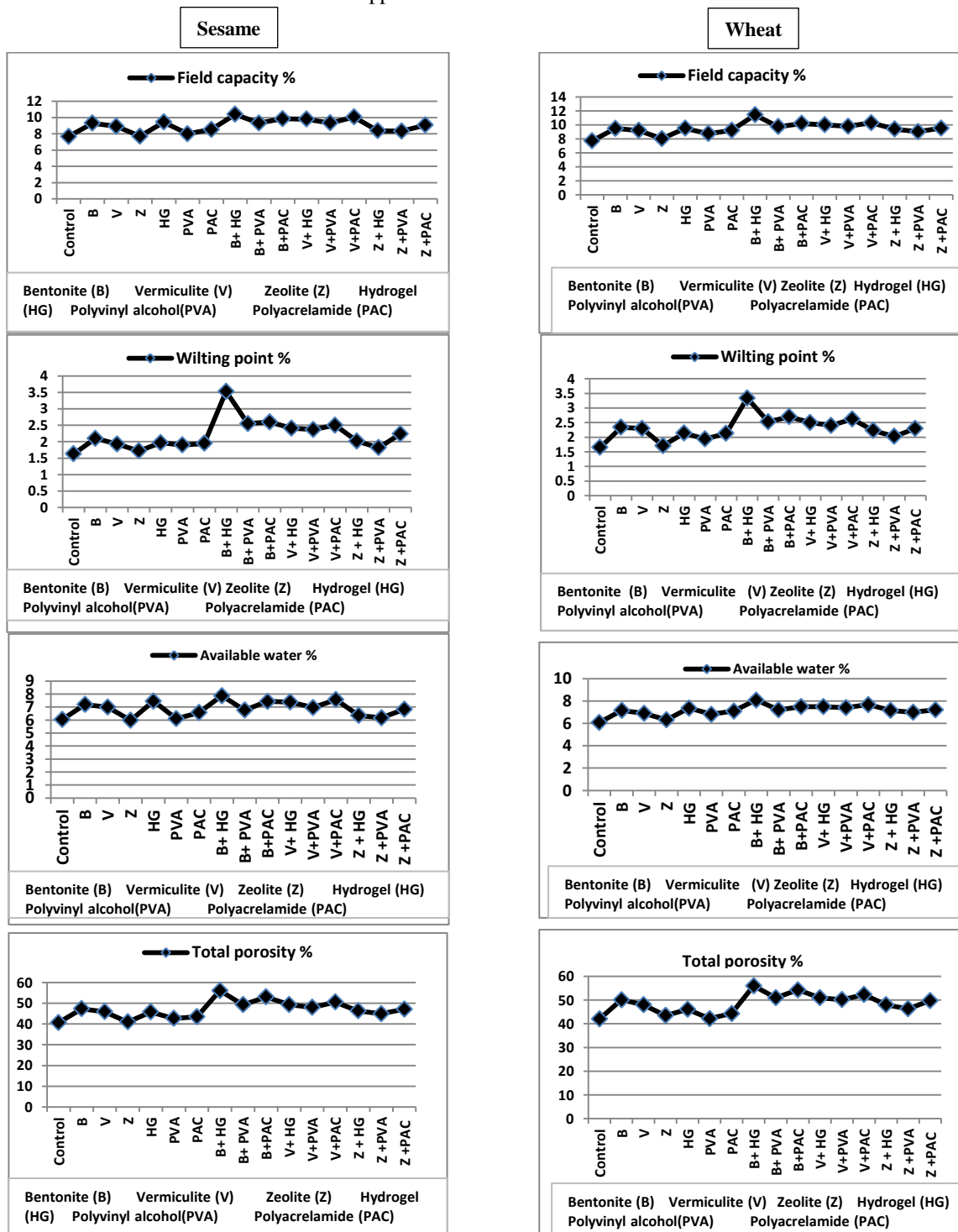


Fig. 1. Effect of applying natural clay minerals and synthetic soil conditioners alone or in combination on some soil physical properties for both tested crops.

B-Chemical properties:

1-Soil reaction (pH)

Data presented in Table (3) indicate that the application of natural clay minerals and synthetic soil conditioners alone or in combination caused a positive response in soil pH values as compared to control in the soil

after harvesting of both sesame and wheat crops under investigation.

As for the individual effect of natural minerals, the data presented indicated that, the values of soil reaction decreased slightly in presence of bentonite, followed by vermiculite and zeolite as compared to control and other natural minerals.

Table 3. Effect of applying natural clay minerals and synthetic soil conditioners alone or in combination, on some soil chemical properties for both tested crops.

Treatments	Sesame					Wheat				
	pH	EC dSm ⁻¹	Available (mg Kg ⁻¹)			pH	EC dSm ⁻¹	Available (mg Kg ⁻¹)		
			N	P	K			N	P	K
Control	7.93	0.30	105.7	13.11	44.33	8.00	0.62	101.0	15.40	60.33
Bentonite	7.45	0.50	165.0	16.33	96.00	7.54	1.09	156.3	19.13	97.83
Vermiculite	7.49	0.37	155.3	15.05	89.00	7.71	1.01	155.0	17.92	94.13
Zeolite	7.52	0.35	146.7	14.28	83.67	7.93	0.88	151.0	15.63	90.33
Hydrogel	7.60	0.42	133.7	19.83	75.33	7.84	1.02	122.3	16.33	89.67
Polyvinyl alcohol	7.81	0.30	108.3	13.02	52.0	8.13	0.65	100.3	14.61	65.33
polyacrylamide	7.67	0.34	120.7	16.10	61.3	7.94	0.73	102.7	15.87	80.00
Bentonite+ Hydrogel	7.41	0.72	184.3	21.23	95.60	7.69	1.04	172.7	24.97	113.00
Bentonite+ PValcohol	7.67	0.54	141.7	13.09	82.33	7.90	0.90	151.7	18.04	98.33
Bentonite+polyacrylamide	7.59	0.61	151.3	14.23	93.00	7.78	1.04	152.3	18.99	104.53
Vermiculite+ Hydrogel	7.60	0.55	131.8	13.77	79.33	7.73	0.91	145.0	15.87	90.33
Vermiculite+PValcohol	7.87	0.52	114.7	12.88	49.33	8.00	0.72	102.5	14.91	61.33
Vermiculite+polyacrylamide	7.44	0.60	154.3	16.24	94.67	7.51	0.96	161.7	17.57	99.80
Zeolite + Hydrogel	7.64	0.47	158.7	16.80	85.33	7.74	1.01	150.7	21.42	101.22
Zeolite +PValcohol	7.67	0.42	131.7	14.49	81.20	8.00	0.88	142.3	17.97	88.30
Zeolite + polyacrylamide	7.54	0.51	164.3	17.97	101.0	7.54	1.12	164.0	19.83	106.33
LSD. 0.05	0.149	0.226	7.337	2.016	3.920	0.192	0.082	7.506	2.726	3.995

Concerning the individual effect of the synthetic soil conditioners forms, the values of soil reaction decreased slightly in the presence of hydrogel followed by polyacrylamide and polyvinyl alcohol (PVA) as compared to control and other synthetic soil conditioners. These observations due to the use of synthetic soil conditioner, which is low pH as mentioned earlier in materials and methods. Such results agree with (Eletr and Osman, 2014).

The interaction effect of natural clay minerals and synthetic soil amendments application on soil reaction (pH), the values of soil reaction decreased in presence of bentonite combined with synthetic soil conditioners especially for hydrogel as compared to other clay minerals combined with synthetic soil conditioners, followed by polyacrylamide combined with vermiculite or zeolite. These observations due to, the use of synthetic soil amendment, which is low pH as mentioned earlier in materials and methods.

2-Electric conductivity (EC):

Data in Table (3) show the changes of electric conductivity as affected by applied natural minerals and synthetic soil conditioners alone or in combination.

Generally, electric conductivity values increased in the presence of natural clay minerals as compared to control, this due to high cation exchange and ion adsorption capacity of bentonite and zeolite. Bentonite could raise the storage capacities of soil for water and fertilizer, reduced the velocity of the downward water movement and restricted the deep percolation and leaching out nutrients (Iskander *et al.* 2011). Moreover, electric conductivity values increased in the presence of bentonite as a natural clay mineral followed by vermiculite and zeolite.

While for synthetic soil conditioners, EC values were slightly increased and the superior was the hydrogel followed by polyacrylamide and polyvinyl alcohol (PVA) as compared to control and other synthetic soil amendments, this trend was true in the soil for both seasons.

With respect to the interaction effect of natural minerals and synthetic soil conditioners application on electric conductivity, EC values were superior in presence of bentonite combined with synthetic soil conditioners especially HG, followed by polyacrylamide and polyvinyl

alcohol, this may be due to high cation exchange and ion adsorption capacity of natural minerals (Iskander *et al.* 2011).

3- Available macronutrients in soil.

Data presented in Table (3) show the changes in soil nutrient availability (N, P and K) after sesame and wheat harvesting. Generally, all applied treatments increased significantly the soil nutrients availability (N, P and K) as compared to control treatments; this trend was noticed for both tested crops. Obtained data may be due to increased moisture retention that enhanced the nutritional supply (Hayat and Ali, 2004), also soil conditioner amendments led to prevent loss of the evaporated water from the soil surface and increase of available water that enhance the availability of nutrient (Ali, 2011).

Concerning to the effect of natural clay minerals, data presented indicated that, natural clay minerals amendments increased significantly the availability of N, P and K soil content, especially for bentonite followed by vermiculite and zeolite as compared with control treatment; this trend was true for both crops. Similar results were obtained by Iskander *et al.* (2011) who found that; bentonite could raise the storage capacities of soil for water and fertilizer and enhance the availability of the nutrients. Moreover, Barton and Karathanasis (2002) found that vermiculite has a substitution of Al₃⁺ for Si₄⁺ in every fourth tetrahedral site results in an excess of negative charge per formula unit. The negative charge is satisfied by monovalent cations, primarily K⁺, that reside on interlayer sites between the 2:1 layers; the network can swell in water and hold a large amount of water while maintaining the physical dimension structure and enhance nutrients availability.

As well as, Ramesh and Reddy (2011) suggested that, adding zeolite increased N use efficiency by decreasing nitrification and NH₃ losses. On the other hand ammonium (NH₄⁺) occupying the internal channels of clinoptilolite; zeolite should be slowly set free, allowing the progressive absorption by the crop which results in a higher dry matter production of crops (Millan *et al.*, 2008)

While for the synthetic soil conditioners, the hydrogel was more pronounced for increasing the nutrient availability followed by polyacrylamide and polyvinyl alcohol (PVA) as

compared with control and other synthetic soil amendments, this may be due to the application of synthetic soil amendments in sandy soil caused a slightly decrease in soil pH, improve the availability of nutrients (Eletr and Osman, 2014).

With respect to the interaction effect of natural minerals and synthetic soil conditioners application, the availability of N, P and K in the soil increased significantly in presence of bentonite combined with synthetic soil conditioners especially HG followed by polyacrylamide

combined with vermiculite or zeolite as compared with control and other treatments.

C-Yield components of sesame and wheat:

Concerning the effect of natural clay minerals along with synthetic soil conditioners on the yield of sesame and wheat, data presented in Fig. (2). showed that the application of either natural clay minerals or synthetic soil conditioners whether applied solely or in combination increased significantly yield components as compared with control treatment.

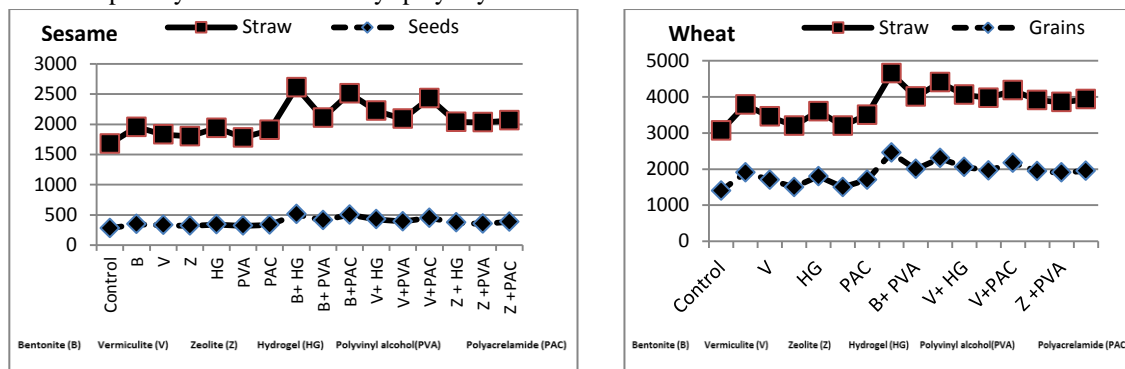


Fig. 2. Effect of applying natural minerals and synthetic soil conditioners alone or in combination on yield components of sesame and wheat crops (kg fed -1).

With regard to the individual effect of natural minerals, results revealed that, yield components of sesame and wheat increased significantly along with the application of natural minerals especially for bentonite as compared to other clay minerals. This may be due to bentonite and zeolite act as carriers of chemical fertilizers and modifying the fertilizers to become long-acting ones, to cause the release of the available constituents of the fertilizers to be in balance with the crop needs and raised the use ratio of yield components (Gan 2005). The same trend was found by Hinsinger (2001) who stated that bentonite and zeolite increased macronutrient and micronutrients in the soil, thus, encouraged plant growth.

Concerning the individual effect of the synthetic soil conditioners forms, yield components of sesame and wheat increased significantly with the presence of hydrogel followed by polyacrylamide and polyvinyl alcohol as compared with control. Such results agree with Orikiriza *et al.* (2013) who found that the hydrogel amendment improved the biomass production of tree seedlings before and after water stress.

With respect to the interaction effect revealed that bentonite combined with hydrogel obtained the highest values of sesame and wheat yield components as compared to other treatments. This may due to the application of inorganic materials, which may be attributed to better soil conditions, enhance the use efficiency of fertilizer by controlled the release of the applied nutrients and reduced nutrient losses (Sarwar *et al.*, 2008). In this respect, Ali, (2011) found that polymers, increase of available water that enhances the availability of nutrients and yield.

Moreover, results indicated that the lowest value of sesame and wheat yield components existed in zeolite combined with polyvinyl alcohol at both studied seasons.

D- Total content of macronutrients for both sesame and wheat crops.

Data in Table (4) show the response of total content (kg fed-1) of macronutrient for both sesame and wheat crops

to the application of natural minerals along with synthetic soil conditioners. The total content of macronutrients (N, P and K) in straw, seeds and grains of sesame and wheat show that all treatments increased significantly the total content of macronutrients as compared with control treatment for both seasons. As for , the effect of natural minerals, results indicate that, the total content of N, P and K increased significantly in presence of bentonite followed by vermiculite and zeolite, this may be due to presence of bentonite could raise the storage capacities of soil for water and fertilizer (Iskander *et al.* , 2011).Moreover, bentonite does not break down over time but remains in the soil to improve nutrient retention; act as a carriers of chemical fertilizers and modifying the fertilizers to become long-acting ones , to release of the available constituents of the fertilizers to be in balance with the crop needs, increasing nutrients in rhizosphere area which increase the absorption by plants, consequently increased the ability of plants roots to uptake more nutrients in plant tissues(Gan,2005) ; while vermiculite has very high cation exchange capacity and hence, other exchangeable cations many supply plant with macronutrients.

Also, vermiculite has very high water absorbing capacity than other minerals thus increasing available soil moisture, and this will affect positively with uptake and dry matter production, (Seddik 2001). Also, presence of zeolites reduce NH3 volatilization, besides several organic forms of nitrogenous sources; reduce in nitrogen by volatilization and increased efficiency of N utilization and can enhance the nitrogen use through the control of retention of ammonium ion, contributing to increase N uptake(Ramesh *et al.*, 2015).

Concerning the synthetic soil conditioners, results indicate that the total content of N, P and K in straw, seeds and grains for both crops under investigation increased significantly in presence of HG followed by polyacrylamide and PVA as compared to the other synthetic soil conditioners due to enhance the use efficiency of fertilizer by controlling of the nutrients release and reduced nutrient losses (Sarwar *et al.*, 2008).

Table 4. Effect of applying natural clay minerals and synthetic soil conditioners alone or in combination on total contents of macronutrients for both sesame and wheat crops.

Treatments	Total contents of Sesame (kg fed ⁻¹)						Total contents of Wheat (kg fed ⁻¹)					
	Seeds			Straw			Grains			Straw		
	N	P	K	N	P	K	N	P	K	N	P	K
Control	5.73	3.56	6.00	10.20	5.14	10.53	5.83	4.20	6.13	9.70	5.67	11.33
Bentonite	12.00	8.63	12.13	14.43	9.21	24.00	12.70	8.33	11.60	13.73	9.53	25.60
Vermiculite	10.40	6.60	9.50	13.00	8.97	23.67	10.27	7.00	9.37	12.63	8.50	22.00
Zeolite	7.77	4.48	8.28	10.27	8.34	22.33	8.40	5.40	8.27	9.67	8.80	20.67
Hydrogel	10.53	7.60	9.07	12.60	10.20	22.77	10.33	8.00	9.10	11.83	9.43	20.67
Polyvinyl alcohol	6.63	4.30	6.47	12.07	6.63	13.47	6.53	5.00	6.90	10.00	6.50	13.10
Polyacrelamide	8.77	6.13	8.07	12.50	7.87	20.00	8.67	6.43	7.67	11.07	7.37	16.17
Bentonite+ Hydrogel	12.00	9.60	12.13	14.40	10.33	26.33	13.00	10.20	11.93	14.33	9.73	22.67
Bentonite+PValcohol	10.40	7.07	7.87	12.00	8.70	23.00	10.03	7.80	7.80	10.03	8.00	18.67
Bentonite+polyacrelamid	11.17	8.33	9.60	12.90	9.17	24.73	11.73	9.00	9.50	12.23	8.80	20.00
Vermiculite+ Hydrogel	8.91	7.02	11.29	11.00	9.81	21.10	9.67	7.13	10.86	11.00	9.00	19.40
Vermiculite+PValcohol	7.94	6.00	9.40	9.54	5.70	20.00	8.50	6.70	9.24	9.03	6.00	18.00
Vermiculite+polyacrelam	12.17	8.87	12.40	13.20	10.92	23.83	12.23	9.47	12.27	12.77	11.13	23.00
Zeolite + Hydrogel	10.40	6.23	8.33	10.20	8.50	18.00	9.21	8.00	8.71	8.11	8.27	16.40
Zeolite +PValcohol	7.17	4.03	7.23	8.20	7.80	17.20	7.87	4.80	7.63	6.80	7.00	14.00
Zeolite +polyacrelamide	11.0	6.50	9.50	11.27	9.50	20.00	10.50	8.27	10.22	9.00	9.00	17.20
LSD. 0.05	0.606	0.596	0.858	0.292	1.117	1.894	0.626	0.633	0.828	0.953	0.989	1.695

Concerning the interaction of natural minerals and synthetic soil conditioners depends on both the properties of soil and polymer and their ability to absorb and/or release water. Application of bentonite combined with HG was significantly superior either for straw, seeds or grains for both crops as compared with control and or bentonite combined with the other synthetic soil conditioners. Such results are confirmed by those of Iskander *et al.* (2011) who stated that bentonite could raise the storage capacities of soil for water and fertilizer; the hydrogels act as a slow release system makes the favoring uptake of some nutrient by holding them tightly and delaying their dissolution.

Moreover, the total content of N, P and K in straw, seeds and grains of sesame and wheat increased significantly in presence of polyacrylamide combined with vermiculite or zeolite as compared to other treatments this may be due to zeolites can hold great potential for the sorption of several metal cations enhance nutrient use efficiency, and gives high productivity to sandy soils (Ramesh and Reddy, 2011).

CONCLUSION

From the obtained results, it could be concluded that addition of natural clay mineral along with synthetic soil conditioners alone or in combination had a significant positive effect on soil moisture characteristics (FC, WP and AW), availability of soil nutrients, nutritional status and yield productivity of sesame and wheat crops.

Also, application of bentonite combined with hydrogel followed by polyacrylamide and vermiculite combined with polyacrylamide had a significant positive effect on total porosity, soil moisture characteristics, EC values, soil nutrients availability and yield components of sesame and wheat.

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السلوك الطبيعي- الكيمياء للمعادن الطبيعية و محسنات التربة الصناعية وتأثيرها علي الحالة الغذائية وإنتاجية المحصول وفاء محمد أحمد صديق ، منى عبدالعظيم عثمان و منى حفنى محمد قناوى معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

أجريت تجربة حقلية في موسمين متتاليين ، موسم صيفي 2017 وموسم شتوي 2018/2017 علي محصولي السمسم والقمح في محطة البحوث الزراعية بالإسماعيلية لدراسة تأثير إضافة المعادن الطبيعية والمحسنات الصناعية سواء فردية أو مختلطة معا علي بعض خواص الأرض الرملية وإنتاجية محصولي السمسم والقمح . تم إضافة ثلاث أنواع من المعادن الطبيعية (بننتونيت – فيرميكوليت – زيوليت) بمعدل 2 طن للفدان مع ثلاث أنواع من محسنات التربة الصناعية (هيدروجيل – بولى فينيل الكحول – بولى كليراميد) بمعدل 6 كجم / فدان . أشارت النتائج إلى أن إضافة المعادن الطبيعية والمحسنات الصناعية منفردة أو مخلوطة معا تزيد مغنويا قيم كلا من الخواص المائية للتربة (سعة حقلية -نقطة الذبول – و الماء الميسر) والمسامية الكلية وتيسر المغذيات (نيتروجين – فوسفور – بوتاسيوم) ومكونات المحصول – المحتوى الكلي للمغذيات الكبرى (نيتروجين – فوسفور – بوتاسيوم) فى القش والحبوب لكلا من السمسم والقمح . أشارت النتائج أيضا إلى أن البننتونيت كان الأفضل بالمقارنة بباقي المعادن بالنسبة للمسامية الكلية والخواص المائية للتربة وقيم التوصيل الكهربى والعناصر المغذية الميسره بالتربة (N-P-K) ومكونات المحصول – والمحتوى الكلي للعناصر المغذية الكبرى (N-P-K) فى الحبوب والقش لمحصولي السمسم والقمح . أما بالنسبة لمحسنات التربة الصناعية فكان لإضافتها للتربة تأثير مغنوي علي زيادة كلا من المحصول والمحتوى الكلي للمغذيات الكبرى فى القش والحبوب للسمسم والقمح بينما انخفضت قيم ال pH بالمقارنة بالكنترول وخاصة في وجود الهيدروجيل . وأشارت النتائج إلى أن معاملة البننتونيت مختلطة مع الهيدروجيل سجلت أعلى القيم لكلا من الخواص المائية للتربة والمسامية الكلية وقيم التوصيل الكهربى والعناصر الميسره بالتربة ومكونات المحصول والمحتوى الكلي للعناصر المغذية الكبرى (N-P-K) فى القش والحبوب لكلا من محصولي السمسم والقمح . بينما معاملة الزيوليت مع البولى فينيل الكحول سجلت أقل القيم لكل الصفات المدروسة.