EFFECT OF BIO- AND SYNTHETIC- POLYMERS ON ENHANCING SOIL PHYSICAL PROPERTIES AND LETTUCE PLANT PRODUCTION

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ABSTRACT

Most of new reclaimed soils in Egypt are light to medium in texture. They are mainly low in porosity, stable aggregates, water retention capacity, and biological activities. The objective is to assess some bio-polymers and synthetic polymers to test their effects on the soil physical properties and on Lettuce plant production.

Seven treatments were applied using bio-polymers (2%dextran, 3%alginate and 3% xanthan) and two synthetic polymers (2 and 3% polyacrylamide and 2 and 3% diaper). These polymers were cheeked for their efficiency in enhancing the microbiological and some physical properties of Toshka soil. The growth performance of Lettuce plant (*Lactuca sativa*) grown in soil for 55 days under open field conditions was considered.

Fresh and dry weights of plant, nutrient contents and the microbiological activity were increased significantly with all bio-treatments amendment. Whereas, synthetic polymers caused negative effects on the previously mentioned parameters.

Concerning the effects on soil properties, dextran treatment recorded the lowest values of total drainable pores (TDP %), the highest values of porosity (%), available water and MWD_{wet}. Whereas, the synthetic polymers amended soil attained negative effect with all these measured parameters compared with control treatment.

The study declared beneficial order of enhancement of soil physical properties and plant production as obtained with Dextran, followed by Alginate, and Xanthan bio-polymers, while synthetic polymers did not show such effects. Hence, the study recommend using bio- polymers instead of synthetic polymers.

Key words: Biopolymers, Synthetic Polymers, Soil Physics, Aggregate Soil Stability, Pore Size Distribution, Soil Conditioners, Lettuce Plant.

INTRODUCTION

The main production challenges of new reclaimed soils of Egypt, like Toshka region in Aswan Governorate are higher bulk density, poor water retention capacity, higher hydraulic conductivity, lower organic carbon content and lower biological activities. Physical quality of most of these soils is often poor due to high percentage of sand which causes macropores resulting in losses of water and nutrients from the root zone by deep percolation and preferential flow (**Singh et al., 2016**). Therefore, producers and researchers alike are interested in improving the physical conditions of these soils and, thus, enhance crop production. These goals can be accomplished by using materials to improve the soil physical and hydro-physical conditions that called soil conditioners **(Neyshabouri et al., 2009)**. Soil conditioners vary greatly in their composition, application rate, and expected or claimed mode of action. They can be natural such as polysaccharides, humus, mulch and manure or synthetic such as polyacrylamide, polyvinyl alcohol, bituminous or asphalt emulsions, silicates of magnesium and aluminum in solution **(Henriquez, 2000 and Sutherland, 2001).**

Soil conditioners can improve soil quality for instance, structure and aeration; increased water-holding capacity (WHC) and availability of water to plants, release of what so called "locked" nutrients, better root development and higher yields and quality. Different soil types vary greatly in their physical, chemical, and biological properties, which influence the effectiveness of soil conditioners **(Green and Juniper, 2004; Martinez and Zinck, 2004; Bot and Benites, 2005, Neyshabouri et al., 2009 and Flemming and Wingender, 2010).**

In a laboratory scale, **Czarnes et al. (2000)** studied the efficacy in enhancing physical and hydro-physical properties and germination and seedling growth of the *Gossypium herbaceum* by using different biopolymers (i.e. xanthan, agar, cellulose, alginate, psyllium gaur gum, and other bacterial exopolysaccharide (EPS) powders. The efficacy of all biopolymers previously mentioned were found to increase more or less WHC, organic matter, total nitrogen, and PWP as compared to the control**.**

The objective of this study is to evaluate the effect of some biopolymers and some synthetic polymers on soil microbiological, soil quality properties and Lettuce plant production in pot experiment under open field conditions.

MATERIALS AND METHODS

To investigate and compare between the effect of biopolymers and synthetic polymers in improving soil physical quality (e.g. the soil porosity, pore size distribution, available water and stability aggregates) and Lettuce plant production. Soil samples were taken from Toshka region in Aswan governorate, Egypt to represent new reclaimed poor structure soils.

1- Soil sampling and characteristics

The soil samples were gently crushed and sieved to < 2 mm. Afterwards, the physical and chemical properties were determined according to the standard methods described by **Page A.L. (1982) and Klute (1986)**.

2- Polymeric substances

In this study, two diversified types of extracellular polysaccharides (EPs) naturally produced by soil microbial cultures were used (i.e. xanthan from *Xanthomonas* isolates; dextran from *Leuconostoc* isolates, and alginate from *Azotobacter* isolates). Isolation of different isolates of *Xanthomonas*, *Leuconostoc* and *Azotobacter* were performed on specific media from various samples which were obtained from the unit of bio-fertilizers, Ain Shams Univ. The screening of potent cultures for each polymer was conducted based on their culture viscosities and on specific productive media. Five isolates of *Xanthomonas*, four *Leuconostoc* isolates and four *Azotobacter* isolates were cultured on different productive media to select the suitable medium for enhancing each polymer production. The biological activity of potent culture for each polymer was determined under optimal nutritional conditions. Whereas, the synthetic polymers; polyacrylamide and diaper polymer were obtained from the Technogene Company in Dokki, Egypt.

3- Seedlings

Seedlings of Iceberg Lettuce (*Lactuca Sativa*) 25 days old were used for pot experiment. These seedlings were obtained from private farm at El Khatatba, El- Monifia governorate, Egypt.

Experimental design

Open field experimental conditions were performed using pots, with, diameter of 14 cm and height of 20 cm, using filter paper at the bottom to prevent the soil from falling out as described by **Jalal and Merrikhpour (2008**). Three treatments were conducted using biopolymers at the efficient rates, namely; dextran (2%), alginate (3%) and xanthan (3%). These rater were recommended in a previous study by **Sodaf Ahmed et al. (2017).**

Two synthetic polymers, namely polyacrylamide and diaper which were used at two ratios (2 and 3%), with five replicates. So, forty pots were used and packed up with 2 kg of sandy clay loam disturbed soil, including five pots as a control treatment (without any treatment).

After preparing the pots, *lactuca sativa* seedlings (25 days old) were cultivated and irrigated to field capacity for fifteen days. After that water depletion processing was done till 80% of field capacity until plant harvest at 55 days. At the end of the experiment, soil particle density, soil bulk density, pore size distribution and wet-sieving were determined using undisturbed soil samples to assess the efficiency of tested polymers on soil quality. Fresh and dry weights, plant nutrient content, dehydrogenase activity and CO_2 evolution were recorded after plant harvest.

Microbiological parameters measured at the end of experimenters

1- Dehydrogenase activity (DHA)

Dehydrogenase enzyme was determined in the rhizosphere soil samples using the reduction of 2.3.5- triphenyltetrazolium chloride (TTC) method described by **Veres et al. (2013)**.

2- CO_2 evolution

The rate of CO_2 evolution was determined in the rhizosphere soil samples according to the methods described by **Jedidi et al. (1993)** and adopted by **Ipinmoroti et al. (1999)**

Plant vegetative parameter

Plants were harvested at the end of the experiment. Whole plant was dried at 70°C for 3 days in oven until constant weight was obtained to record its dry weight.

1- Soil analyses at the end of experiments

At the end of the experiments, undisturbed soil samples were collected from the pots. Bulk and particle density, porosity, aggregate size fraction and stability testing of soil were determined according to **Mashhour et al. (2009)**. Pore size distribution was determined according to **Nimmo (2004).** In addition, aggregate size fractionation and stability testing of bulk soil was determined by wet sieving according to **Nimmo and Perkins (2002).** Also, the percentage of water-stable aggregate (WSA) was calculated as shown in the following Eq. 1:

$$WSA = 100 * \sum_{i=n}^{n} Mi \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The aggregate mean weight diameter (MWD) was calculated as shown in Eq. 2:

$$MWD = \sum_{i=n}^{n} XiMi \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where: MWD is the mean-weight diameter of the WSA (mm), Xi: is the mean diameter of each size fraction (mm), Mi: is the proportion of the total WSA in the corresponding size fraction, n: is the number of size fractions, and i = 1, 2. . . . 5% **(Manuel et al., 2016)**.

Statistical analyses

The effect of different ratios of bio-polymers and synthetic polymers on soil physical and hydro-physical quality and plant growth were assessed by one-way ANOVA and the Tukey's multiple range tests at a level of significance of $P < 0.05$ using Costat program (version 6.400) described by **Arun and Rattan (2017)**.

RESULTS AND DISCUSSIONS

The efficiency of using some biopolymers and synthetic polymers for enhancing poor physical and hydro-physical soil properties, and Lettuce plant production showed the following results.

Characteristic of soil sample

Table 1 shows some physical and chemical properties of the studied soil sample. The obtained data indicated that the soil sample has sandy clay loam texture, 1.63 g/ cm^3 bulk density, low total porosity (35.12%) and particle density of 2.51 g/ cm^3. The percentage of organic matter and calcium carbonate content were very low. The soluble salts content was also low (less than 4.0 dS/ m at 25°C). As such, the soil sample can be classified as non-saline described by **Mohammed et al. (2016)**.

Table 1. Some physical and chemical properties of the studied soil sample

* Particle size distribution %				Texture class	ρ_s g/cm^3	ρ_b g/cm^3	*f* %	OM %	$CaCO_3$ %	** EC_e (dS/m)	PH (peste)
Clay	Silt	Fine Sand	Coarse Sand								
30.11	5.17	42.81	21.91	Sandy Clay Loam	2.51	1.63	35.12	0.17	1.54	1.35	7.90

Each value is the mean of three replicates.
ρ_s is the Particle density.
ρ_b is the Bulk density. ***f* %** is the percentage of porosity.
According to ISSS classification. ** Electrical conductivity at 25°C in soil paste
* extract.

Soil structure as affected by the added polymers

A- Soil porosity

Porosity is the fraction of the total soil volume that is occupied by the pore space. As a basic physical property of soil, bulk density not only affects the availability of soil moisture and nutrients, but also indirectly reflects on soil quality and productivity (**Reichert et al., 2009**).

Data of the soil particle and bulk density as well as porosity as influenced by polymer treatments are shown in **Table 2**.

Data in **Table 2** indicated that the highest values of porosity were recorded for dextran (39.13). On the other hand, the lowest values were recorded for daiper polymer ratios. Statistical analysis revealed that the soil porosity data show significant differences between every treatment with the control. This can be noticed easily where treatments have the same letter are not significant at the 5% level according to LSD-test. Slight significant differences were found between DIP ratios and control**,** these findings agreed with those obtained by **Roa-Espinosa et al. (2000) and Green and Juniper (2004).**

Table 2: Particle and bulk density, and percentage of porosity of studied soil samples cultivated with *Lactuca sativa* and treated by bio and synthetic polymers

Type of polymer	Ratio of polymer (%)	ρ_s (g/cm^3)	ρ_b (g/cm^3)	*f* %
Control	0	2.47	1.6	35.22 a
Dextran	2	2.3	1.4	39.13 e
Alginate	3	2.33	1.42	39.06 d
Xanthan	3	2.36	1.49	36.86 c
Polyacrylamide (PAM)	2	2.46	1.59	35.26 a
	3	2.45	1.55	35.20 a
Daiper polymer (DIP)	2	2.45	1.56	35.99 b
	3	2.45	1.55	35.36 b

Each value is the mean of five replicates.
Means having the same letter in each separate column are not significantly different at the 5 % level according to LSD-test. **ρ_s**: Particle density, **ρ_b:** Bulk density, ***f***%: Percentage of porosity

Generally, the beneficial order of enhancement soil porosity was in the order: biopolymers dextran > alginate > xanthan and synthetic polymers; daiper polymer, respectively.

B- Pore size distribution

Pore size distribution (PSD) and available water (AW) were concluded from soil water retention curves as described by **Nimmo, J.R., et al. (2004)**

The changes in pore-size distribution arising from mechanical loading, chemical treatment, plant root growth, freezing and thawing, or other influences, often need to be taken into account in interpreting experimental results **(Sheng-Gao et al. 2014, Malik and Sheng-Gao. 2015).**

Data of the pore size distribution; FCP, WHP and TDP of soil cultivated with *Lactuca sativa* in the presence of different bio and synthetic polymers are shown in **Figure 1**. These data indicated that the lowest values of TDP% were recorded for dextran (28.7%) against 58.29% for the control treatment. On the other hand, the highest values of TDP% were recorded for synthetic polymers and ranged from 50.65, with 3% to 52.15 with 2% of DIP, respectively. Various effects were noted by increasing both synthetic polymers from 2 to 3%. Decreases in TDP% in cultivated soil indicated a good effect which means improving soil structure. Also, data indicated that the highest values in WHP% were recorded for dextran. On the other hand, the lowest values were recorded for synthetic polymers from 4.67, with 3% DIP to 5.4 in presence of 3% PAM. Increasing in WHP% in sandy clay loam soil occurred which means improving soil structure.

Also, data indicated that the highest values in FCP% were recorded by dextran (19.46%) increased by 70.0% than control. On the other hand, the lowest values were recorded by synthetic polymers being 6.10 and 6.55% for DIP at 3% and PAM at 3%. Various effect were noticed by increasing the ratios of both synthetic polymer from 2 to 3%. These results agreed with those obtained by **Green and Juniper (2004)**.

In general, statistical analysis of measured parameters (FCP, WHP and TDP) stated significant differences between all treatments and control indicating positive effects when biopolymers were used and negative effect with synthetic polymers. The used of biopolymers increased WHP% and decreased TDP% and FCP%, total drainable pores TDP %, and vice versa when using synthetic polymers.

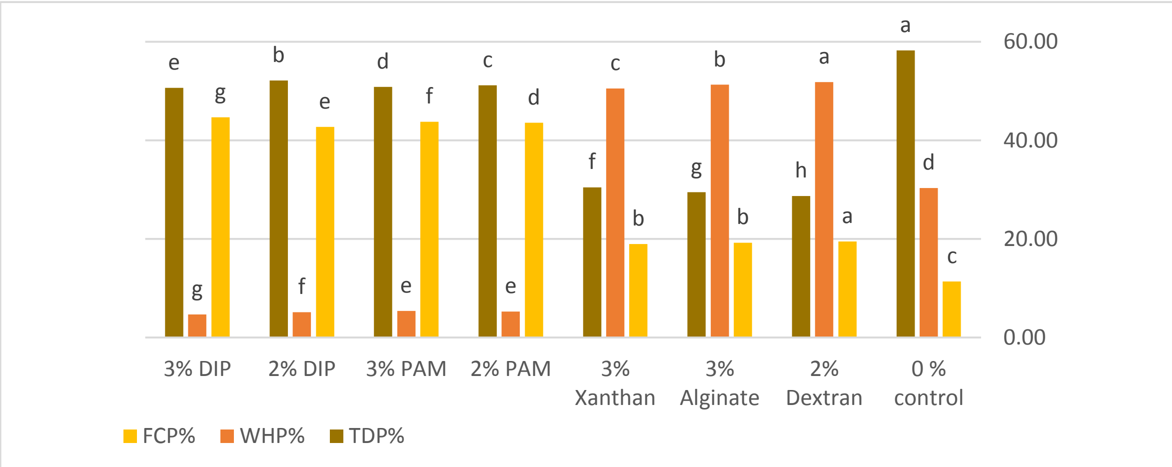

Figure 1: Pore size distribution of sandy clay loam soil cultivated with *Lactuca sativa* and treated by bio and synthetic polymers

C- Available water content

Available water content (AW) calculated from subtraction of volumetric water content at field capacity from that at permanent wilting point. Data of the available water content are presented by **Figure 2**. Data indicated that the highest values of AW% were recorded for dextran (24.71%). On the other hand, the lowest values were recorded for synthetic and polymers ranged from 2.4, with 3% DIP to 3.13 with 2%DIP. On top of the immense water holding capacity of the biopolymer itself, which increases the soil water content, **Martinez and Zinck (2004)** suggested that this increase can be partly attributed to the biopolymer separating soil particles and consequently maintaining a more open pore structure.

Statistical analysis of AW% showed significant differences between all treatments and control; but the positive effects were obtained by using biopolymers. This agreed with the results of **Barthes and Roose (2002)**. Increasing in AW% values in sandy clay loam (cultivated soil) is beneficial effect which means enhancing water holding capacity, and hence improve soil hydro-physical quality and vice versa, when using synthetic polymers.

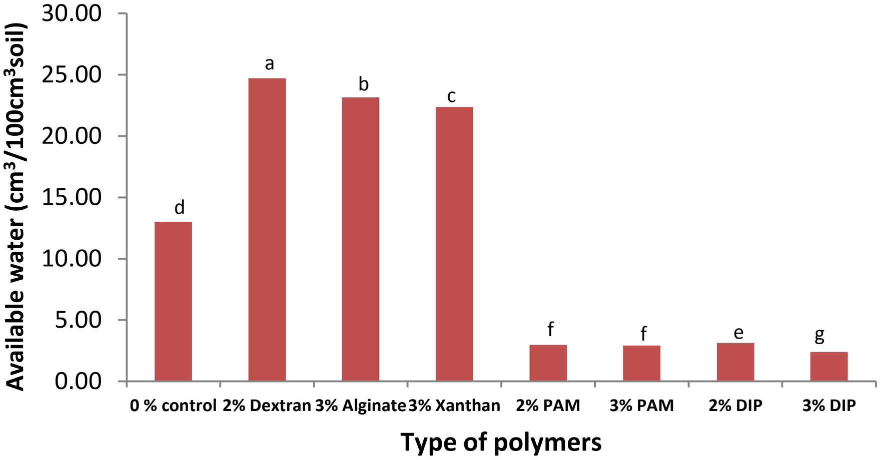

Figure 2: Available water (cm^3/ $100cm^3$ soil) of sandy clay loam soil cultivated with *Lactuca sativa* and treated by bio and synthetic polymers.

D- Stability and size distribution of soil aggregates

Data of distribution of soil aggregates and MWD_{wet} are shown in **Table 3**. Data revealed that biopolymers treatments improved the percentage of soil stable aggregates especially the aggregates with diameters above 1 to 10 mm and decrease the aggregates with diameter below 1 mm. Dextran amended soil scored increasing in percentage of soil stable aggregates. Their corresponding figures were 31.24, 32.6 and 5.66% for aggregates with diameters in values of 1- 2, 2 -5 and 5 to 10 mm, respectively. On the other hand**,** synthetic polymers treatments led to decrease the percentage of soil stable aggregates, with diameter ranged from 0.25 to 5 mm compared to the control. PAM amended soil recorded 27.45, 0.02, 9.36% at 3% and 26.36, 9.36, 10.22 at 2% for 0.25 to 1, 1to 2

Table 3: Distribution and stability of aggregates of sandy clay loam soil cultivated with *Lactuca sativa* and treated by bio and synthetic polymers

Type of polymer	**Ratio of polymer (%)**	**Aggregates diameters (mm)**					**MWD_{wet} mm**
		<0.25	**0.25-1**	**1-2**	**2-5**	**5-10**	
		Distribution of aggregate fractions (%)					
Control	**0**	37.08	37.26	14.79	10.8	0.00	0.88 d
Dextran	**2**	15.44	15.05	31.24	32.6	5.66	2.01 a
Alginate	**3**	18.15	20.58	28.75	29.2	3.24	1.77 b
Xanthan	**3**	20.56	19.53	27.42	29.8	2.64	1.74 c
Polyacrylamide (PAM)	**2**	52.37	26.36	9.36	10.2	1.68	0.81 e
	3	61.52	27.45	0.02	9.36	1.65	0.66 f
Daiper polymer (DIP)	**2**	54.70	25.80	9.03	9.33	1.14	0.75 e
	3	54.89	27.66	7.23	8.20	2.02	0.74 e

Each value is the mean of five replicates.
Means having the same letter in each separate column are not significantly different at the 5 % level according to LSD-test.

and 2 to 5mm diameter aggregates, whereas DIP recorded 25.8, 9.03, 9.33 at 2% and 27.66, 7.23, 8.20 at 3% in respective order.

Moreover, data indicated that the highest values in MWD_{wet} were recorded for dextran (2.01mm) followed by alginate and xanthan. On the other hand, the lowest values of MWD were recorded by synthetic polymers in ranging from 0.66 to 0.81 mm. Statistical analysis of MWD_{wet} showed again significant differences between all treatments and control; but positive effect was observed the when biopolymers were used and negative effect when synthetic polymers were used compared with the control treatment.

Generally, increasing in soil porosity, AW and Stable aggregates beside increasing PSD values due to using biopolymers in sandy clay loam (cultivated soil) is considered good effect. It means that improving physical and hydro-physical soil properties. Vice versa effects were obtained when using synthetic polymers. These results may be attributed to the effect of organic matter content of microbial biomass and microbial byproducts including cell wall residues and extracellular polysaccharides as explained by **Mashhour et al (2009), Neyshabouri et al. (2009)** and **Mohamed (2017).**

Based on the above, we concluded that biopolymers had positive effect in improving the physical and hydro-physical soil properties, this was consistent with **GarcõÂa-Ochoa et al. (2000)**, **Peng et al. (2011)**, **Afsheen et al. (2012)**, **Kwon et al. (2017)**, and **Hien Xuan et al. (2018)**, While the results were not agree with **Ben-Hur. (2006)** and **Dębicki. (2013)**; might be due to the high percentages used from synthetic polymers in this study, where the recommended rates in their researches were from 0.001 to 1%.

Growth response of lettuce (*Lactuca sativa*) as affected by the polymers

A- Growth performance

Seedling developments are critical phases in the early growth and establishment of any plant. In arid and semiarid environments, water retention capacity plays a key role in the growth and establishment of crops.

It was observed that addition of biopolymers to sandy clay loam showed potential effects on seedling growth and biomass production **(Table 4)**.

Data in this Table present the dry and fresh weight and nutrient content of *Lactuca sativa* plant as affected by polymers treatments. Obviously results indicated stimulatory response of dry and fresh weights of plant due to the amendment with biopolymer compared with synthetic polymer and control treatments. In this respect, fresh and dry weights of *Lactuca sativa* plants were increased significantly from 470.3 and 17.5 g/ plant the control treatment to 655.2 and 28.5 g/ plant for dextran and to

Table 4: Effect of bacterial and synthetic polymers amendment on plant growth and nutrient content of *Lactuca sativa* plant grown in sandy clay loam.

Polymer type	Concentration used	Total plant mass g/plant		Plant nutrient content					
				Total nitrogen		Total phosphors		Total potassium	
		Dry weight	Fresh weight	N %	Uptake mg/plant	P %	Uptake mg/plant	K %	Uptake mg/plant
Control	0	17.5d	470.3	0.63	1c	0.46	0. 8bc	1.10	2c
Dextran	2%	28.5a	655.2	1.05	3a	0.84	2a	1.95	6a
Alginate	3%	21.1b	560.3	0.84	2b	0.55	1b	1.60	3b
Xanthan	3%	19.6c	530.1	0.91	2b	0.66	1b	1.49	3b
Polyacrylamide	2%	16.0e	370.2	0.35	0. 5e	0.27	0. 4c	0.65	1c
Polyacrylamide	3%	13.0g	350.4	0.28	0. 3f	0.24	0. 7bc	0.55	0. 7d
Diaper polymer	2%	14.4f	349.6	0.49	0. 7d	0.35	0. 5c	0.75	0. 1c
Diaper polymer	3%	12.0h	330.3	0.42	0. 5e	0.33	0. 4c	0.63	0. 7d

560.3 and 21.1 g/ plant for alginate treatments, respectively. Dextran at ratio of 2% exhibited the highest effect on fresh and dry weights of plants followed by alginate (3%) treatments.

Moreover, it was observed that the studied synthetic polymers gave significantly the lowest values of fresh and dry weights of plant. Dextran improved the plant growth by 39.34% and 62.86% in fresh and dry weights of plant compared to the untreated soil (control).

Data in **Table 5** represent the nutrient content as percentage and plant uptake as influenced by biopolymers and synthetic polymers treatments. In general, plants grown with biopolymers treatments contained high amounts of nitrogen, phosphorus and potassium than control and synthetic polymer treatments. The most pronounced effect of this application was manifested in plants grown with dextran treatment giving 30mg N/ plant ، 20mg P/ plant and 60mg K/ plant for plant uptake. Synthetic polymers at different ratios recorded significantly the lowest values of nitrogen, phosphorus and potassium uptake which ranged from 3 to 5, 4 to 7 and 7 to 10 mg/ plant, respectively. Alginate treatment at 3% gave less nitrogen and phosphorus uptake for *Lactuca sativa* plant than that obtained with xanthan (3%) treatment, whereas xanthan recorded potassium uptake higher than alginate treatment. It was observed that synthetic polymers gave high values of nitrogen, phosphorus and potassium uptake at ratio of 2% than 3% of polymer ratio.

The superiority of nutrient uptake was recorded for dextran treatment which increased nitrogen, phosphorus and potassium uptake by 3, 2.5 and 2.5 fold as compared with the control treatment. In this concern, **Patil et al. (2011)** found that addition of biopolymer showed high potential effects on seedling growth of *Gossypium herbaceum* plant and biomass production.

B- Soil microbial activity

In this study, enhancement in microbial population was observed in all biopolymers amendment. **Table 5** presents the biological activities of cultivated soil with different treatments of biopolymers and synthetic polymers.

Table 5: Effect of biopolymers and synthetic polymers on microbial activity in the rhizosphere of *Lactuca sativa* plant grown

Polymer type	**Conc. used**	**CO_2 evolution ($\mu g CO_2$/100g soil)**	**Dehydrogenase activity (µg TPF/100 g soil)**
Control	0	154d	10.18c
Dextran	2%	286a	43.89a
Alginate	3%	220c	24.20b
Xanthan	3%	231b	25.35b
Polyacrylamide	2%	77g	4.2e
	3%	66h	2.57f
Diaper polymer	2%	110e	5.30d
	3%	88f	4.41e

Each value is the mean of five replicates.

In order to assess the rate of microbial activity in the pots during experimental period (55 days), the CO_2 released as an indicator of soil respiration rate was tested. Appreciable increase in respiration rate (CO_2 evolution) after biopolymer treatments probably indicates that all optimized concentration for water holding capacity and porosity were adequate. Among the biopolymer treatments, biopolymers indicated the highest respiration rate, which may be due to high organic carbon content. CO_2 evaluation increased significantly in all biopolymer amendments especially with dextran (2%) treatment. Synthetic polymers gave low respiration rate compared to biopolymer and control treatments. Dextran recorded the maximum respiration rate of 286mg CO_2/100g which increased by 85.71% over the control treatment and by 271.43% over polyacrylamide (2%) treatment. The synthetic polymers treatments gave drastically decreases of CO_2 evaluation ranged from 76.92% to 61.54% decreases comparing to dextran treatment. These results are in agreement with those of **Dong et al. (2004)** who reported that polyacrylamide treatment reduces total bacterial, microbial biomass and total fungal biomass relative to the control treatments. The dehydrogenase activity measurement technique has the advantage to quantify the number of live cells in the ecosystem and it can be employed in a relatively short time and at a low cost **(Alisi et al., 2008**). The soil dehydrogenase activity provides correlative information on the biological activity and microbial populations in soil. Using soil enzymes activity as a measure of microbial indicators for soil fertility was discussed by **Vikash et al. (2017) and Alceu et al. (2018).**

Table 5 revealed that biopolymers treatments at optimal ratio in sandy clay loam soil cultivated with (*Lactuca sativa*) increased significantly the microbial population and hence the biological activities in the rhizosphere. The effect of all biopolymers on dehydrogenase activity was remarkable when compared to control treatment. The highest response of dehydrogenase activity was recorded with dextran treatment at 2% followed by alginate and xanthan treatments. The control treatment gave 10.18ug TPF/ 100g soil in the rhizosphere and the synthetic polymers recorded different values of dehydrogenase activity (DHA) ranged from 2.57 to 5.3ug TPF/ 100g soil. Dextran treatment gave the superiority of dehydrogenase activity in the rhizosphere plant after 55days of transplant being 43.89µg TPF/ 100g soil. So, it improved the microbial population (dehydrogenase activity) by more than four folds as compared with the control treatment. Similar results were interpreted by **Patil et al. (2011)** who reported that increase in microbial population in natural polymer amendment was due to the high availability of organic carbon, good aeration, and moisture availability. This, consequently, might have increased the activity of soil microorganisms. Also, **Warrick (2002)** stated that alginate amendment also showed comparable results with phylum and bacterial polymer.

Based on the above, we concluded that biopolymer addition showed positive significant effects, while synthetic polymers had negative significant effects on the physical properties of soil. This was reflected on the growth performance and soil microbial activity and lettuce plant production, this was consistent with **Gonzaga et al. (2018)** and **Marchi et al. (2015) and Sevinç et al. (2018)**.

CONCLUSION

In our study summary, we found that the addition of biopolymers treatments (i.e. Dextran, 2%, Alginate, 3% and Xanthan, 3%; these percentages are recommended) to poor structural soil cultivated with Lettuce plant in open field pots experiments, enhanced soil physical and hydro-physical properties (i. e. the soil bulk density, the porosity, Pore size distribution, available water and stable water aggregates) relative to control. Whereas, using of synthetic polymers treatments (i.e. polyacrylamide, 2 and 3%, and diaper, 2 and 3 %; to simulate previous ratios) caused inversely effect on the previous parameters of soil quality. Moreover, the effects of biopolymers and synthetic polymers treatments on soil properties were reflected on soil microbial activity and the growth performance and lettuce plant production. Fresh and dry weights of plant, nutrient contents and the microbiological activity were increased significantly with all bio-treatments amendment. Whereas, synthetic polymers treatments caused negative effects on the previously mentioned parameters compared with control treatment.

Consequently, the study declared beneficial order of enhancement of soil physical and hydro-physical properties and lettuce plant production as obtained with Dextran, followed by Alginate, and Xanthan bio-polymers, while synthetic polymers did not show such effects.

On the other hand, the costs and benefits of lettuce production in similar experimental conditions was successfully with dextran but not economic with Alginate and xanthan biopolymers treatments. Where, the net profit under using dextran treatment was 0.28 $/5 plant. Nevertheless, Alginate and xanthan biopolymers may be economically with other plants.

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تأثير إضافة البوليمرات الحيوية و الصناعية على تحسين الخواص الفيزيائية للتربة و إنتاجية الخس النامي بها

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الملخص العربي

تتصف الأراضي حديثة الإستصلاح فى مصر بأن أغلبها ذات قوام متوسط إلى خفيف. ويعتبر قلة النسبة المئوية لمسامية التربة و ضعف أو إنعدام بناءها و إنخفاض قدرتها على مسك والإحتفاظ بالماء وقلة النشاط الميكروبي فيها من محددات الإنتاج الرئيسية. إستهدفت الدراسة تقييم تأثير بعض البوليمرات الحيوية (الدكستران والألجينـــات والزنثان) بالإضافة إلى البوليمرات الصناعية (البولي اكريلاميد وبوليمر الحفاضات) على تحسين بعض الخواص الفيزيائية الهامة لتربة من منطقة توشكا لتمثل الأراضي حديثة الإستصلاح، مع دراسة أثر ذلك على إنتاجية نبات الخس المنزرع تحت الظروف الحقلية. أستُخدم في الدراسة سبع معاملات هي الدكستران ٢% و الألجينات والزنثان ٣% و البولي أكريلاميد وبوليمر الحفاضات بنسب ٢ و ٣%.

أوضحت النتائج وجود تاثيرات معنوية نتيجة إستخدام البوليمرات الحيوية على تحسين خواص التربة وإنعكس ذلك على إنتاجية النبات. كان بوليمر الدكستران أفضلهم تاثيراً على الوزن الجاف والطازج للمحصول وكذلك على محتوى النبات من العناصر الغذائية والنشاط الميكروبي فى منطقة الريزوسفير وكذلك تحسين بعض الخواص الفيزيائية المُقدرة للتربة وهى زيادة المسامية مع تقليل مسام الصرف الكلية وزيادة مسام مسك الماء والماء الميسر ودرجة ثبات التجمعات الارضية. أما البوليمرات الصناعية فقد أظهرت تأثيراً سلبياً على خواص التربة المُقدرة مما إنعكس سلباً على إنتاجية النبات تحت ظروف التجربة. وبصفة عامة كان التأثير الإيجابي على تحسين الخواص الفيزيائية للتربة و إنتاجية محصول الخس كالتالي: الدكستران ثم الألجينات يليه الزنثان. وأوصت الدراسة بعدم إستخدام البوليمرات الصناعية نظراً لتأثيراتها السلبية على خواص التربة وإنتاجية الخس النامي بها.

كلمات مفتاحية: البوليميرات الحيوية، البوليميرات الصناعية، فيزياء التربة، ثبات التجمعات الأرضية، التوزيع الحجمي لمسام التربة، نبات الخس.