European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 06, Issue 01, 2019

Effect of Agriculture Polymers and irrigation levels on Yield of wheat at desert soils properties in Al-Mmuthana Governorate

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Abstract

A field experiment was carried out in the Badia of Al-Muthanna, Faidat Umm Al-Shih, for the 2018-2019 season, to determine the effect of adding levels of agricultural polymer and levels of irrigation on some chemical and physical properties of the soil and the production of wheat crop (*Triticum aestivum* L.). The experiment included three levels of Absorption Sup super (ASP Polymers (0, 40 and 80) kg ha (P0, P1 and P2) and four levels of irrigation (W3, W4, W5 and W6). Three seasons, four seasons, five seasons, and six seasons, the soil was divided into three replicates to find out the best number of irrigations with the best amount of polymer added in production and the characteristics of the studied soil. The results showed the effect on the soil properties, the addition of the agricultural polymer at a level of 80kg ha and the irrigation level W6 showed a significant decrease in the electrical conductivity of the soil, reaching 1.9 decimens, the CEC values also increased to 13.80 cmol, which is the highest level, and the bulk density values decreased to the level of 1.39 gm cm^3, which was the lowest level in the experimental treatments. As for the soil reaction, it reached the lowest level (7.60 pH) against the level of polymer P1, as for the effect on wheat production, it was significant, as the biological yield reached the polymer level 80 kg ha, 11.95 megagrams ha^{-3}, which was the highest production achieved by the experimental treatments, while the yield of the wheat crop was 5.55 megagrams ha^{-3}, which was the highest. The effect of irrigation levels on biological production and productivity reached the highest irrigation level (W6), where it was respectively 11.40 and 4.51 mg ha^{-3} as an average, as the study showed that the addition of 80 kg/ha agricultural polymer with six irrigations per season gave good productivity and significantly affected Positive on soil physical and chemical properties in desert soils.

Keywords: Agriculture Polymers, irrigation levels, Yield, wheat, desert soils, Al-Mmuthana Governorate.

Introduction

The percentage of desert lands in Iraq is more than 50%, and many agricultural lands continue to be decertified, as a result of water scarcity, climate change conditions and great pressure on available water resources, which prompts us to search for new methods of saving water and saving it and producing agricultural crops with the same areas and less water, the use of modern technologies in the use of irrigation water is one of the important matters in sustainable development and reducing irrigation water, and preserving them in the drought conditions that the world is going through, especially desert soils and dry soils, also, improving the soil's physical properties is a key factor in preserving soils from erosion or deterioration, polymers are very important in all areas of life and can be manufactured according to the purpose required of them by making a simple change in their composition or mixing them with each other or through covalent bonds (Abad *et al*., 2009).

Polymers are used in many fields, including (engineering, medical, food, and industrial), in the agricultural field, it is used to save irrigation water and not leak it through the soil, they are absorbed by the plant when the humidity level is low, where there is an important type called Polymers Absorption Sup super, they are water adsorption polymers or water retention polymers, it is important in improving irrigation water use efficiency and improving soil water-holding qualities, reducing irrigation water, reducing the permeability of sandy soils, and increasing the permeability of clay soils, soil protection from erosion and increased moisture stress, polymers have very important advantages as they do not pollute the soil and are biodegradable at a rate of 10% annually, this makes it economical and can be used in the soil for several years, as well as not remaining in the soil as pollutants (Katayama *et al*., 2008).

The polymers are made of acrylic acid and potassium in an aqueous solution - as a cross-linking agent, it is called pulquerlite and is characterized by its ability to expand and retain water, it does not contain any toxicity and cannot be oxidized, the polymers adsorb more than 500 times their volume of water when the soil is dry, the plant begins to absorb the water trapped in the polymer granules, and this increases the efficiency of the irrigation process, polymers also hold fertilizers and pesticides and keep them from leaking into groundwater and losing them, which leads to groundwater pollution, desert soils are characterized by a light sandy texture, which makes their retention of irrigation water poor (Al-Ghanmi and Al-Husseini, 2017).

It needs very large quantities of irrigation water and many irrigations, and this is inconsistent with the conditions of drought and water scarcity, the area of Al-Muthanna Desert is 20 million dunums, most of which are arable, the importance of preserving groundwater and exploiting large areas with smaller quantities of water emerges. Rationalization may reach 35% (Saudi, 2013). *Triticum aestivum* L. is one of the most important strategic crops, the country needs in light of the increase in the global population and the rise in prices in general, securing food security for the country, providing hard currency and great job opportunities to reduce unemployment, exploitation of the desert leads to soil stabilization from erosion, reduces dust storms significantly, influences temperature reduction, climate change impacts, ecological and vital balance, and biodiversity protection, contribute effectively to achieving balanced sustainable development and preserving vital resources, especially groundwater, which is considered a national wealth upon which the country relies in conditions of scarce rain and lack of water revenues from the Tigris and Euphrates rivers. (EL-Fouly *et al*., 2011).

This study aims to reduce the quantities of irrigation water required for agricultural production. As well as improving soil properties, especially physical, and stabilizing soil from erosion.

Materials and methods:

Location and treatments experience

The study was carried out in Al-Muthanna desert, in the Badia of Al-Muthanna, Faidat Umm Al-Shih, for the 2021-2022 season, 75 km, its soil is sandy. It needs a large number of irrigations, which may reach 10 irrigations in the wheat production season, and this requires large quantities of water and leads to the costs of pumping water and extracting it from artesian wells.

The experiment was carried out in 2021 from 1/11/2021 to 15/4/2021

Where the harvest took place, where the wheat cultivar IPA 99 was planted, its seeds were obtained from the Field Crops Department in the College of Agriculture, Al-Muthanna University.

It used 3 levels of Absorption Sup super (ASP Polymers) 0, 40, 80 kg ha and 4 levels of irrigation 3,4, 5, 6 irrigations per season, where the polymer was added in the form of lines with the seeds at once, and the irrigations were distributed over the polymer treatments.

After selecting the experimental land, it was plowed using a tipper plow. It was smoothed and leveled manually. The number of experimental units was 36 units according to the design used. The area of the experimental unit was 1 m2. Seeds were sown in the form of lines, the length of the line was 1 meter, and the distance between one line and another was 15 cm. Then samples were randomly taken from 6 sites in the experiment, where they were transferred to the laboratory and measurements were made as in Table (1).

Table (1) physical and chemical properties of the study soil.

Item	Value
Clay (%)	120.00
Sand (%)	600.00
Loam (%)	280.00
The bulk density (megagrams. m^{-3})	1.40
The true density (megagrams. m^{-3})	2.40
Porosity (%)	41.00
Ec (dms m)	3.20
pH	7.70
Organic matter (gm kg^{-1})	1.10
Gypsum (gm kg^{-1})	1.90
Lime (calcium carbonate)	390.00
CEC (centimoles kg^{-1})	10.20

The studied traits of the soil: Soil electrical conductivity (CEC), Cation Exchange capacity (EC), pH, Soil Bulk Density:

The studied traits of the plant traits: High Plant, biological yield, amount of yield.

Design to experience:

The method of factorial experiments was applied using the (R.C.B.D) design, completely randomized sections with three replications, and the number of experimental units reached 36 experimental units. After the crop matured, (0.5 m^2) from each experimental unit was harvested from the center lines.

Results and discussion:

Effect of polymer addition and levels of irrigation (W) on the degree of reactivity of the experimental soil (pH):

Table (2) showed that the addition of the agricultural polymer had a significant effect on reducing the pH values of the soil during the harvesting process, where it showed that the lowest result was (7.51) in the polymer treatment at the P2 level) and did not differ significantly from the average (7.59 in the P3 treatment). The highest result was in the control treatment P0 (no polymer addition) and reached 7.64, as it showed that the polymer had an effect on reducing the degree of soil interaction, had a positive role, it is attributed to improving the physical properties of the soil and agrees with what was indicated by Bai et al. (2015) where they showed that the polymer lowers the soil PH.

Table (3) indicate that increasing the number of irrigations for the wheat crop had a clear effect on reducing the pH of the soil, where the lowest mean was at treatment W6, which is the highest number of irrigations, due to washing with some basic elements such as calcium and magnesium. The highest value of PH was in the W3 treatment, i.e. three irrigations only, and this reflects the conditions of drought.

Table (2) The effect of the polymer and the irrigated number and the interaction between them on pH.

Polymer (kg ha^{-1})	Irrigated number				Mean
	W3	W4	W5	W6	
P0	7.71	7.61	7.65	7.50	7.62
P1	7.60	7.55	7.45	7.40	7.51
P2	7.65	7.59	7.47	7.60	7.59
Mean	6.65	7.52	7.52	7.50	

CEC at harvest:

Table (3) indicate that the agricultural polymer had a significant effect on reducing the values of electrical conductivity EC.e in the soil, as it reached the lowest average value of 2.9 dSm in treatment P2, and was significantly superior to the remaining levels.

As for the highest level, it was in the treatment P0, which is the comparison treatment (without adding an agricultural polymer), as the electrical conductivity reached 2.7 dSm, due to the role of the agricultural polymer in absorbing water by about 300-500 times its volume, and this leads to reducing the impact of salts in the soil, as the concentrations of salts decrease, which is reflected in the reduction of electrical conductivity (Domingues et al., 2020).

As for the effect of the number of watering, the minimum electrical conductivity reached 1.9 dSm in the treatment (W6), which is the highest number of watering, significantly superior to the rest of the averages.

As for the highest average electrical conductivity, it was at the level (w3), and this reflects the effect of the number of irrigations in leaching salts from the soil and helps in reducing the electrical conductivity clearly (Kong *et al*., 2015).

Table (3) The effect of the polymer and the irrigated number and the interaction between them on CEC.

Polymer (kg ha^{-1})	Irrigated number				Mean
	W3	W4	W5	W6	
P0	3.20	3.00	2.50	2.10	2.70
P1	3.00	2.80	2.30	2.00	2.50
P2	2.90	2.70	2.10	1.80	2.40
Mean	3.00	2.80	3.20	1.90	2.50

Positive ion exchange capacity (EC) (centimol of charge kg^{-1} soil):

Table (3) shows that there was an increase in the cation exchange capacity with the increase in the addition of the agricultural polymer, as the average amounted to 13.56. We will finance a kilogram charge in the P2 treatment, which is the highest of the treatments, with an increase of 20% over the control treatment (without adding polymer), as the composition of the agricultural polymer has a major role in carrying ions cation and not allowing it to be easily washed off. As for the role of irrigation, it was close in its effect on increasing the cation exchange capacity, and no clear significant differences appeared (Zhang et al., 2013).

Table (4) The effect of the polymer and the irrigated number and the interaction between them on EC.

Polymer (kg ha^{-1})	Irrigated number				Mean
	W3	W4	W5	W6	
P0	11.12	11.50	11.52	11.40	11.39
P1	13.23	13.40	13.55	13.50	13.42
P2	13.40	13.44	13.60	13.80	13.56
Mean	12.58	12.78	12.89	12.90	

Effect of agricultural polymer addition and levels of irrigation on Bulk Density of soil:

The results showed that the bulk density was significantly affected, as it was the lowest decrease in the polymer treatment P2, where it was 1.36 gm cm^3, which is the highest treatment, and the highest level was in the comparison treatment P0 (without adding polymer), as it reached 1.43 gm cm^3, and the reason for the decrease in the real density is due to the low density of the polymer Which contributed to reducing soil density, and here its effect is similar to the effect of organic matter (Kibet *et al*., 2022).

Table (5) The effect of the polymer and the irrigated number and the interaction between them on Bulk Density of soil.

Polymer (kg ha^{-1})	Irrigated number				Mean
	W3	W4	W5	W6	
P0	1.45	1.46	1.43	1.39	1.43
P1	1.40	1.39	1.41	1.36	1.39
P2	1.35	1.38	1.37	1.35	1.36
Mean	1.43	1.41	1.40	1.40	

Plant height (cm):

Table (6) show the effect of polymer levels and irrigation on reactivity of wheat plant.

Table (6) showed that the effect of the addition of agricultural polymer was significant on the characteristic of plant height, where the level compared to the comparison treatment P0 (no addition of the polymer) and the levels of the polymer P1 and P2 achieved average heights of 67.72 and 77.19 cm, respectively, as the comparison treatment recorded an average of 62.86 cm, and the level P2 excelled at Level P1 is morale, and this is due to the fact that the agricultural polymer saves water and prepares it for the plant at the time of lack of moisture in the soil, where the roots of the plant can extract the water contained within the polymer granules without stress or waterlogging.

Table (6) indicate that the effect of irrigation levels was significant on plant height values, as the average plant height in treatment W6 reached 80.48 cm, an increase of 15% over treatment W3. As for treatment W5, the average plant height was 73.81 cm, and in treatment P2 agricultural polymer compared to the level of irrigation W6 The height of the plant was 95.55 cm, which is close to the rates of cultivar height in natural conditions, that is, six irrigations in desert soils with the addition of a polymer at P2 level, which gives an appropriate height, as the conditions of desert soils in Muthanna Governorate reach the number of irrigations from (8-10) to achieve this level in conditions of no addition Agricultural polymer, which saves large amounts of irrigation water.

Table (6) The effect of the polymer and the irrigated number and the interaction between them on plant height (cm).

Polymer (kg ha^{-1})	Irrigated number				Mean
	W3	W4	W5	W6	
P0	55.21	60.35	65.44	70.44	62.86
P1	59.45	65.55	70.44	75.45	67.72
P2	62.44	70.23	80.55	95.55	77.19
Mean	59.03	65.38	73.81	80.48	

Biological yield:

Table (7) showed that level P2 of the agricultural polymer was significantly superior to level P1 and P0, it reached 11.95 µg.ha-1, where the P0 level was 9.56 µg.ha-1, while the P1 level was 10.61 µg.ha-1. This reflects the role of the polymer in preserving water and nutrients and passing them to the plant on a regular basis, especially at the P2 level, where it gave The highest production of the biological crop, as the height of the plant, the branches, and the vegetative total of the plant in general increases.

Table (7) shows that the highest average of irrigation levels is (W6), where the rate was 11.40, while the lowest rate was the level of irrigation (W3), which was 9.11 megagrams. Hectare-1, where it was found that level W6 gave the highest biological yield, outperforming the rest of the levels. It reflects the role of the agricultural polymer in reducing the number of irrigations needed to obtain good production with fewer irrigations to save water and the economic costs associated with irrigation, such as fuel, human effort (E1 Mostapha *et al*., 2005).

Table (7) The effect of the polymer and the irrigated number and the interaction between them on Biological yield.

Polymer (kg ha^{-1})	Irrigated number				Mean
	W3	W4	W5	W6	
P0	6.51	10.54	10.40	10.80	9.56
P1	9.61	10.45	10.95	11.44	10.61
P2	11.20	11.51	11.70	11.95	11.95
Mean	9.11	10.83	11.01	11.40	

Grain yield:

The P2 level of agricultural polymer addition was significantly superior, reaching 4.46 μg. ha^{-1} over the P0 level, which amounted to 3.33 μg. hectares and the P1 level, which was 3.52 megagrams. hectares, and this is clear, the effect of adding the agricultural polymer on increasing the productivity, and the highest production was in the treatment of the agricultural polymer P2 and the irrigation level W6, where the productivity was recorded as 5.55 megagrams. Hectare-1 As for the lowest production, it was in the agricultural polymer treatment against the level of irrigation W3, i.e. three irrigations per season, the lowest reading was recorded and reached 2.75 megagrams hectares (Wanas and Omran, 2006).

Table (8) The effect of the polymer and the irrigated number and the interaction between them on Grain yield.

Polymer (kg ha^{-1})	Irrigated number				Mean
	W3	W4	W5	W6	
P0	2.75	3.25	3.50	3.95	3.33
P1	3.12	3.10	3.80	4.05	3.52
P2	3.60	3.75	4. 95	5.55	4.46
Mean	3.16	3.36	4.08	4.51	

Conclusions:

It was shown that the level of agricultural polymer P2, which amounted to 80 kg / ha, achieved the highest production in plant yield. Irrigation level W6, six irrigations per season, achieved the highest yield and plant components. The level of the agricultural polymer P2 had the most effect on soil properties. The polymer remains in the soil for five years, and only the decomposer is compensated, which does not exceed 10%.

Recommendations:

We recommend the use of 80 kg / ha of polymer to achieve an increase in production. The use of agricultural polymers in desert soils for its significant role in reducing water waste, preserving nutrients, and contributing to non-pollution of groundwater. Providing polymer material or manufacturing it locally to benefit from it, especially since it does not pollute the environment and does not cause toxic or epidemiological damage, and is analyzed annually at a rate of 10%. Six irrigations in desert soils with a polymer of 80 kg / ha gave the highest yield, so we recommend that it be followed. Adding every year 10% of the weight of the polymer, as it decomposes at a rate of 10% annually.

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