

EFFECT OF SOME CHEMICAL ADDITIVES ON REDUCING THE PERMEABILITY OF AGRICULTURAL SOILS AND THE CONSUMPTION OF IRRIGATION WATER DURING THE PLANTATION OF POTATOES 'OUED SOUF'

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ABSTRACT

Agriculture is an important sector in Algeria, it is the second economic component of the country, however the country suffers from water shortage and high soil permeability, especially in the Sahara region, The Sahara area in Algeria accounts for about 85% of its total area, the Algeria's Sahara considered as the most arid region in the world and has a high soil permeability, Leading to consume a large quantities of water for irrigation. In order to solve these problems, hydrogels are the effective solution proposed. Hydrogels have the capacity of holding a large amount of water and keep it close to the plant's roots. The purpose of this study was to estimate the effect of hydrogel on soil permeability by application of three different dosage of Hydrogel in three parcels. The results proved that the addition of hydrogel enabled to yield 50% more production, using almost 50% less water.

Keywords: Agriculture; Soil permeability; Hydrogel; Biodegradable.

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1. INTRODUCTION

Agriculture has been developing from long time ago in all around the world and especially in USA and Europe. These developments have made it possible to double production and



increasing crops. However, many countries have damaged from these developments such as North African countries, which have had adverse effects both on the natural environment (various pollution, soil erosion etc.) and on the human environment. This type of agriculture commonly called conventional or productivity agriculture.

Algeria is one of the countries that already based on agriculture as a second economic sector after petroleum industry. There are many various crops (vegetables, fruits, dates...) are grown in Algeria along the year.

Despite government efforts, there is a big challenge for farmers where the reserve water decreasing every year with fast rate, due to high consumption and fast climate change.

Algeria is the first largest country on the African continent and has to deal with fairly large differences in climate. Algeria is known for its Sahara Desert, oases and the Atlas Mountains. The country consists for around 85% of Sahara. It has a long coastline and the coastal areas have a mild Mediterranean climate with hot summer, cool and rainy winter. In the highlands summers are hot and dry. Winter rains (less heavy then the coast) in the highlands begin in October. In the months January, February and March there are many sandstorms and sahara known with an arid climate, cool winter and heat wave along the summer.

Farmers in the northern regions rely on rainwater and dams for irrigation. In the sahara, farmers concentrate on groundwater, which is threatened by drought.

Potatoes considered as the most vegetable produced in the country. The state of the El Oued is the most productive state of the potatoes in Algeria. El Oued located in the southeast of Algeria in the sahara, the potato occupies an importance in the market gardening of the state, and more than 1/6 of total surface is reserved for the potatoes. It represents more than 1/3 of the total production of vegetable crops. For an area of around 466.80 h in 1995/96.

Currently, according to the statistics during only 04 years the surface is multiplied by 05 going of 1686 h.

The soil of the region is a typical soil of the Saharan regions. It is a poor soil in organic matter, sandy texture and structure characterized by very high-water permeability which means huge need of water for irrigation, and as we know the quantity of groundwater in the region is sharply decreasing, and it is the right of future generations as well, for environmental

sustainability.

Soil permeability depends on the chemical and mechanical composition of the soil, its structure, its porosity, its density and its moisture.

So, what is the easy and effective way to reduce the permeability of soils?

And what is the solution that allows to conserve groundwater for the coming generation?

For that. Hydrogel is the proposed solution for reducing the soil permeability in the region of El Oued.

1.1 What is hydrogels?

Hydrogels form three-dimensional networks composed of hydrophilic and potentially biocompatible polymers. These materials contain two phases a solid phase formed by the polymeric network, and a second liquid phase (aqueous). By their affinity with water, hydrogels are able to absorb for more than 400 times of their dry mass [1]. The synergy of these two phases thus makes it possible to obtain soft and elastic materials. The hydrogels can be chemically stable or degradable because they can also dissolve or disintegrate. Depending on the environmental conditions, it is possible to find them in different structural forms: amorphous, semi-crystalline, supramolecular or in the form of colloidal aggregates. The entire three-dimensional (3D) network of hydrogels is maintained by bonds that can be of physical (hydrogen bond) or chemical (covalent bond) origin.

Acrylamide is a main component employed for preparation of agricultural hydrogel products [2].

Polyacrylamides are one of the widely used hydrophilic polymers (hydrogel), they are produced by the polymerization of acrylamide (C_3H_5NO), a compound obtained by the hydration of acrylonitrile. Acrylamide is usually dissolved in water; it has toxic effects on the nervous system and must be handled under special protective procedures. The dissolved monomers (single-unit molecules) are induced to polymerize (link together to form large, multiple-unit molecules) through the action of free-radical initiators. In the resultant polymer, the acrylamide repeating unit has the following structure:

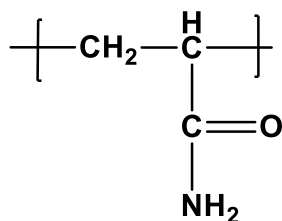


Fig.1. The chemical structure of the acrylamide repeating unit

Acrylamide monomer is neurotoxic, but polyacrylamide is not toxic[3], and can form aqueous solutions of very high concentration.

We can distinguish two types of polyacrylamide hydrogel: linear polyacrylamide and cross-linked. Linear polyacrylamide dissolves in water and used in agriculture for reducing irrigation, and cross-linked polyacrylamide does not dissolve but becomes gel when it mixes with water it also can used in agriculture [4], laboratory supplies [5] and many different sectors.

2. RESULTS AND DISCUSSION

2. 1. Hydrogel effect on the amount of water consumed

Through the recorded numbers of water meters in different parcels (P₁, P₂, P₃ and P₄), proved that application of hydrogel enabled to reduce the amount of water consumed, where's the higher dose used, the less water consumed. The avarege of results obtained are shown in Table 1.

Table 1. The amount of water consumed

Parcels	Water consumed (m ³)
P ₁	641
P ₂	516
P ₃	437
P ₄	334

As a comparison between P₄ and P₁, water consumed for irrigation in P₄ is almost half of water consumed in P₁ during the experiment period.

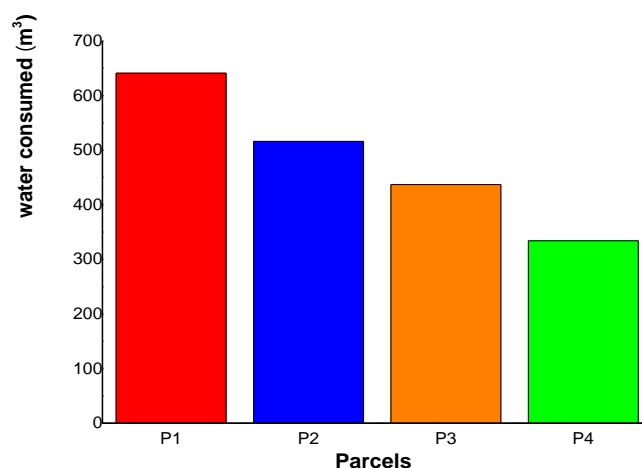


Fig.2. Variation of water consumed (m^3) in different parcels

2. 2. Hydrogel effect on the biomass

By the end of the experiment, the shape of plants showed a large difference, where the average measuring of the plants' length in the 4th parcel were best growth and taller than they were in P₃, P₂ and P₁. And they were respectively (75cm, 65cm, 55cm, and 50cm).

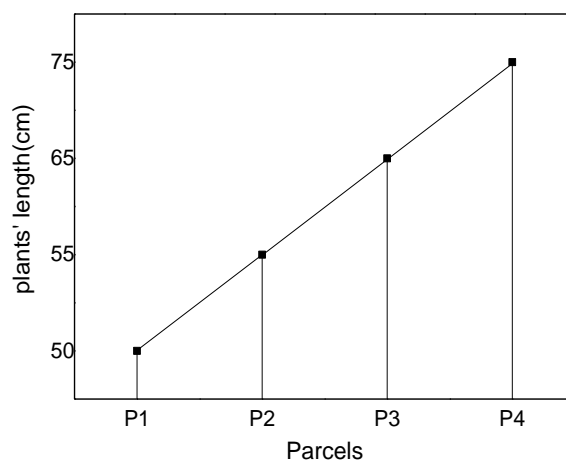


Fig.3. Variation of plants' length (cm) in different parcels

2. 3. Hydrogel effect on the production

The results were obtained in this experiment in different parcels show that addition of the gel in P₂ (Dosage = 15g) was the most productive than the others and the yield potatoes was up to 6.79 kg for one planet, which is more than the double productivity in P₁.

The productivity in P₃ and P₄ was very close, and P₁ was the lowest productivity. The average results obtained are showing in figure 4.

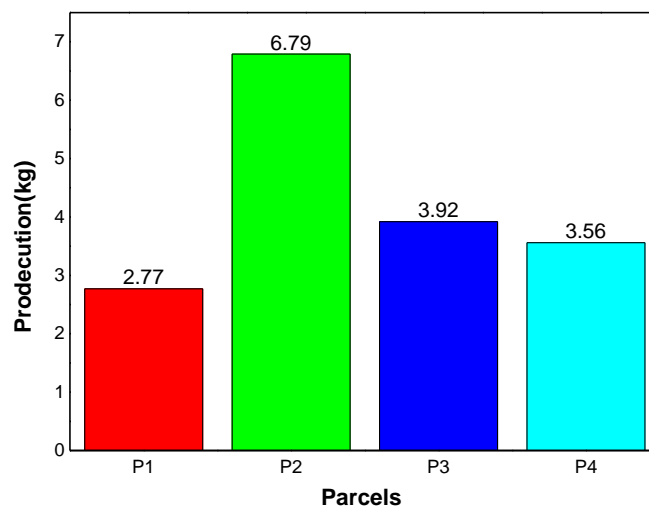


Fig.4. Variation of the produced potatoes (kg) in different parcels

3. EXPERIMENTAL

The studied soil classified as a sandy soil, in area located in Kouinine in central El-oued (Longitude 47.07¹49⁰6 E, and Latitude 6.53¹24⁰33 N), the area has an arid climate, with a rain scarcity, and very high temperatures in the summer and low in the winter.

The physical and chemical characteristics of the soil are shown in Table 2.

Table 2. The physical and chemical characteristics of the soil

Characteristics	Depth 30 cm	
Granulometry	Silty	17.4%
	Fine sand	74.4%
	Coarse sand	6.6%
pH		7.34
Organic material		0.83%
Total limestone		17.8%

The additive hydrogel is called AgroNanoGel Basic, produced in Poland. Table 2 shows the

properties of AgroNanoGel Basic Hydrogel.

Table 3. The properties of AgroNanoGel Basic Hydrogel

properties	AgroNanoGel Basic Hydrogel
Absorbency	(450-600ml/g)
pH	neutral
Biodegradability	10 years
Toxicity	Non-toxic
Influence on soil microorganisms	No negative impact on the soil microorganisms

To realis this study 250g of hydrogel was mixed with 25L of water. Then four different dosage of the gel were applied on four parcels whereas the first parcel (P₁) has left without hydrogel. The quantities of the dosage are listed on Table 4.

Table 4. Dosage quantities.

Parcel	Dosage
Parcel 1(P ₁)	0g
Parcel 2(P ₂)	15g
Parcel 3(P ₃)	30g
Parcel 4(P ₄)	40g

Drip irrigation was used in this study; it was realized by smart system irrigation by using a device programmer.

The programmer connected to electrical sounds and electric valves, water meter are also used to count the amount of water consumed in each parcel, this system works to keep moisture ratio between 60% and 70% in the soil in all parcels all the time, the goal of this system allow each parcel has the quantity of water it needs, neither too much nor too little, and this ensures steady growth of potato seeds.

3.1. Hydrogel application method

Hydrogel (gel form) was mixed with sand at 20 cm of soil depth. According to the Table 2 the dosages have been done in each parcel.

The plantation process has been done manually, where the potato seeds have been placed over the mixture (sand/gel), and then have been covered with sand.

4. CONCLUSION

The addition of hydrogel made it possible to:

- Reduce irrigation water consumption by 50% even though in the arid and semi-arid region.
- Give plants steady growth, and it also increase plants biomass improvement.
- Increase the productivity to double.

Hydrogel is biodegradable, economic solution, environment friendly and it is able to ensure sustainable agriculture with a high productivity.

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