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The Impact of Hydrogel Polymer Technology on Abiotic Stress of Water on Plant

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ABSTRACT

Owing to the impacts of climate change, the increase in global demand for water is already a threat in arid and semi–arid and several regions which is aggravating contest of the limited amount of obtainable water by completely different sectors, ranging from urban needs, industrial sector and agricultural sector which is regarded as one of the most critical sector with the most demand and consumption of water. In the same vein, irrigation water stress is one of the most important limiting factors that have an effect on crop and fruit growth and productivity. Accordingly, this study assessed the utilization of hydrogel polymer technology in managing abiotic stress of water crops. Hydrogels have been used broadly for improving water availability for plants, by increasing water holding properties of soil and growing media, application of hydrogel polymers may be a proper technique to enhance water and fertilizers use efficiencies. Hydrogels have the capacity to absorb and store water many times their weight and work as a tank to forestall water waste and increase irrigation potency, also, superabsorbent polymers improve some soil physical properties. The application of hydrogel in arid and semi–arid regions improve soil properties, increases the water holding capacity of the soil, enhances the soil water retention ability, improves irrigation efficiency, increases the growth of various crops, and enhances water productivity of the crop. It also provides a conducive atmosphere for the better growth of roots in well–drained soils and ultimately increases yield. This study concludes that hydrogel can be used as an absorbent in environment preservation in the agricultural sector as water retention, soil conditioners, and nutrient carriers.

Keywords: Water, Stress, Abiotic, Water retention, Hydrogel

INTRODUCTION

Globally, over seventy percent of fresh water is used for agriculture; by 2050 feeding a planet of nine billion individuals would require associate degree calculable fifty percent increase in agricultural production and a fifteen percent increase in water withdrawals. During the last decade, hydrogels have been used broadly for improving water availability for plants, by increasing water holding properties of soil and growing media, application of hydrogel polymers may be a proper technique to enhance water and fertilizers use efficiencies [3], it might absorb and store water many times of their weight and work as a tank to forestall water waste and increase irrigation potency, also, superabsorbent polymers improve some soil physical properties [8]. Research evidence suggests that when the soil is treated with water hydrogel composite the water volumetric content of the soil increases significantly and when the surrounding soil dries, the stored water is released back slowly into the soil. The hydrogel increase efficient water consumption, decreasing irrigation costs and increasing irrigation intervals, also, it implement soil's water holding capacity and soil porosity, providing plants with eventual moisture and nutrients as well as enhancing plant viability and ventilation and root development which provides a conducive atmosphere for better growth of plants and finally increases crop yield. Hydrogel has various characters like the high swelling and the slow water retention encourage their use as safer

release systems for fertilizers and as a soil conditioner in agricultural applications. Hydrogel polymer is particularly valuable in agricultural sector since they can retain water and reduce land erosion.

Overview of Polymer Hydrogel

Polymer hydrogels is classified as a Super absorbent polymer, it's measure visco–elastic, loosely crosslink, and hydrophilic three–dimensional networks of versatile polymer chains with unconnected ionic purposeful group that may absorb an oversized quantity of water or alternative biological fluids in an exceedingly short time and retain them beneath sure conditions and considered as a soil conditioner which hold up to thousand times of their existing weight of water and increase crop yield [6]. Hydrogel polymer have the ability to absorb water in quite a hundred times its original weight within short period of time and desorbs the absorbed water under stress condition [11].

There are three groups of a polymer as follow:

i. Starch–polyacrylonitrile graft polymers (starch co–polymers),
ii. Vinyl alcohol–acrylic acid co–polymers (polyvinyl alcohols)
iii. Acrylamide sodium acrylate co–polymers –cross–linked polyacrylamides

Mode of Action for Polymer Hydrogel

When the hydrogel is mixed with the soil, it forms an associate amorphous gelatin–like mass on hydration and is adept of absorption and desorption for an extended time, thus acts as a slow unharness supply of water within the soil. The hydrogel particles are also taken as "miniature water reservoir" in the soil and water will be detached from these reservoirs upon the root mandate through osmotic pressure difference. Due to the respectable volume reduction of the hydrogel as water is released to the plant, hydrogel creates at intervals the soil, free pore volume providing further space for air and water infiltration, storage and root growth [2]. Hence hydrogel polymer deed as a slow–release basis of water and dissolved fertilizers in the soil [7]. Water conservation by hydrogel creates a buffered setting being effectiveness in short–run drought tension and losses reduction in institution phase. Ability in water consumption and dry matter production square measure positive crop reactions to hydrogel, once polymers are mixed into soil, they preserved vast quantities of water and nutrients reach up to hundred times of its original weight and conserve regarding ninety–five percent of keep water out there for plant absorption, which are released as required by the plant, therefore, plant growth was enhanced with limited water supply (Johnson, 1984), however, in rainfall region adding hydrogel polymer to soil implement soil infiltration rates [4].

Characteristics of Hydrogel Polymers

The key characteristics of hydrogel polymers which makes them a perfect candidate for with standing water stress in crop production are listed below:

i. Exhibits maximum absorbency at temperatures (40-500C) characteristic of semi-arid and arid soils.
ii. Absorbs water 400 times its dry weight and gradually releases the same.
iii. Stable in soil for a minimum period of one year.
iv. Low rates of soil application –1-2 kg / ha for nursery horticultural crops; 2.5-5 kg/ ha for field crops.
v. Reduces leaching of herbicides and fertilizers.
vi. Helps plants withstand prolonged moisture stress.
vii. Improves physical properties of soils and soil less media.
viii. Improves seed germination and seedling emergence rate.
ix. Improves root growth and density.
x. Reduces nursery establishment period.
xi. Reduces irrigation and fertigation requirements of crops.
xii. Promotes early and dense flowering and fruiting/tillering.
xiii. Delays onset of permanent wilting point.
xiv. Extensive root growth resulting in increased water and nutrient use efficiency.

Agriculture Specific Applications of Hydrogel

Though hydrogels are specific inventions for agriculture, still there are some specific applications of it in agriculture field which are being listed below:

Effect of the Hydrogel in Retaining the Water

Due to water resource crisis, water–saving agriculture is essential for sustainable development. Hydrogel polymer improve water penetration rate, hydrogel polymer have been used as water retaining material in arid and semiarid region under limitation of supplementary irrigation sources and salinity conditions which affect negatively on gradual growth and productivity of crops. Hydrogel is used to increase a water reservoir near the root system,

increase the field capacity of different soils, and also increase both water available for plants and the period of its availability.

Effect of Hydrogel on Plant Growth

Seed germination and seedling establishment are considered the most important phases in the initial growth of any plant kinds; the successful establishment depends on available water and is regularly restricted by low level of soil moisture mainly in arid and semi–arid regions [1]. Hydrogel polymers enhances plant growth by swelling water holding capacity in soil and prolong the time till it reaches wilting point which increasing plants survival under water stress [9], decreasing fruit drop ratio, and may lead to expanded total yield and fruit weight under various severity conditions. Furthermore, [5] reports that added hydrogel to the soil increased the plant circumference; this may be due to the increasing amount of available water in the root zone, which infers longer irrigation intervals.

Effect of Hydrogel on Nutrients

Hydrogel application minimizes micronutrients from washing out to water tables and increase water consumption efficiency; also, it's reducing the quantity of fertilization, since the nutrient leaching is prohibited by decreasing runoff. Alternatively, hydrogels which contain fertilizers and have controlled water release so that the dose of the fertilizer is adjustable in time. The nutrient is available for the plant over a longer period of time rather than a rapid availability that ammonium nitrate, ammonium phosphate or potassium chloride [10].

CONCLUSION

The application of hydrogel in arid and semi–arid regions improve soil properties, increases the water holding capacity of the soil, enhances the soil water retention ability, improves irrigation efficiency, increases the growth of various crops, and enhances water productivity of the crop. It also provides a conducive atmosphere for the better growth of roots in well–drained soils and ultimately increases yield. According to chemical and physical structures of hydrogels, it can be used as an absorbent in environment preservation in the agricultural sector as water retention, soil conditioners, and nutrient carriers.

REFERENCES

[1] Abdel-Raouf AM, Samira RM. Improving soil physical properties andits effect on acacia tortilis seedlings growth under field conditions. Asian Journal of Plant Sciences. 2003;2(11):861–868.
[2].Azzam RA. Agricultural polymers. Polyacrylamide preparation, application and prospects in soil conditioning. Communications in Soil Science and Plant Analysis. 1980;11(8):767–834.
[3]. Dehkordi KD, Seyyedboveir S. Evaluation of super AB A 200 Superabsorbent on water use efficiency and yield response factor of SCKaroun701 corn under deficit irrigation. Advances in Environmental Biology. 2013;7:4615–4622.
[4]. Helalia A. Letey J. Cationic polymer effects on infiltration rates with a rainfall simulator. Soil Science Society of America Journal. 1988;52(1):247–250.
[5]. Johnson MS. Effect of soluble salts on water absorption by gel forming soil conditioners.
Journal of Science and Food Agriculture. 1984;35(10):1063–1066.
[6]. Li YK, Xu TW, Ouyang ZY, et al. Micromorphology of macromolecular superabsorbent polymer and its fractal characteristics. J Appl Polym Sci. 2009;113(6):3510–3519.
[7]. Milani P, França D, Balieiro AG, et al. Polymers and its applications in agriculture. Polímeros. 2017;27(3):256–266.
[8]. Montesano FF, Parente A, Santamaria P, et al. Biodegradable superabsorbent hydrogel increases water retention properties of growing media and plant growth. Agriculture and Agricultural Science Procedia. 2015;4:451–458.
[9]. Orikiriza LJB, Agaba H, Tweheyo M, et al. Amending soils with hydrogels increases the biomass of nine tree species under non-water stress conditions. Clean-Soil Air Water. 2009;37(8):615–620.
[10]. Rahman MS, Sarker AM, Islam MS, et al. Effect of soil moisture on grain yield of wheat (Triticum aestivum L) cultivars. Environment and Ecology. 2001;19(2):304–308.
[11]. Zhang J, Li A, Wang A. Study on Superabsorbent composite. VI. Preparation,
Characterization and swelling behaviors of starch phosphate-graft-acrylamide/attapulgite Superabsorbent composite. Carbohydrate Polymers. 2006;65(2):150–158.

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