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Super Absorbent Polymers - Application and Benefits in Agriculture

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SUMMARY

In arid and semiarid regions with limited water availability, the use of water-holding amendments like hydrogel polymers material for improving water and nutrient use efficiency will become more crucial over time. The hydrogel is able to store water and plant nutrients and release them to the plants when surrounding soil close to the root zone of plants begins to dry up. In fact, by 2030, global water demand is likely to be 50% higher than it is today, leading to water scarcity. At the same time, the agricultural sector currently uses more than 70% of freshwater in most parts of the world, making water management one of the biggest challenges for all countries in arid and semi-arid regions. Many characteristics of hydrogel, such as their high swelling and slow water retention, promote their usage as safer fertiliser release systems and as a soil conditioner in agricultural applications. Since they can hold onto water and stop soil erosion, hydrogel polymers are especially useful in the agriculture industry. The purpose of this work is to illustrate the function and applications of hydrogel polymer in the agricultural sector, namely how it can improve soil characteristics, increase fertiliser usage efficiency, and regulate irrigation to conserve water.

INTRODUCTION

The majority of super absorbent polymers used in agriculture are made via solution or suspension polymerization from acrylic acids and a cross-linking agent like potassium. The polymer created in this way is known as a polyacrylate, and the amount and type of cross-linker utilised considerably influences its swelling capacity and gel modulus. A novel kind of macromolecular synthetic water absorbing polymer material is known as Super Absorbent Polymers, sometimes referred to as SAP, hydrogel, absorbent polymers, absorbent gels, super soakers, and water gel. SAPs are typically hygroscopic materials with a white sugar-like appearance that swell in water to produce a clear gel consisting of distinct individual particles and can hold moisture even under pressure without burning up or rupturing/blasting. In order to create the majority of the super absorbent polymers used in agriculture, acrylic acids and a cross-linking agent like potassium by solution or Very Absorbent The majority of polymers used in agriculture are made via solution or suspension polymerization from acrylic acids and a cross-linking agent like potassium. The polymer created in this way is known as a polyacrylate, and the amount and type of cross-linker utilised considerably influences its swelling capacity and gel modulus. Polyacrylates have been shown to be biodegradable with a degradation rate of 10%–15% annually. They are non-toxic, non-irritating, and non-corrosive by nature. They exhibit a high capacity for water absorption and may freely release 95% of the same when plant roots apply suction pressure.

Application and Benefits

Low soil water retention capacity, high evapo-transpiration rates, and soil moisture leaching are the three most typical soil characteristics that limit plant development and agricultural yield. In addition to these, elements such as unanticipated drought conditions, degradation and salinization, excessive use of synthetic fertilisers and pesticides, and inappropriate irrigation techniques have a negative impact on soil and plants, frequently causing long-term harm to the soil biota.

Desirable Attributes for Applications in Agriculture

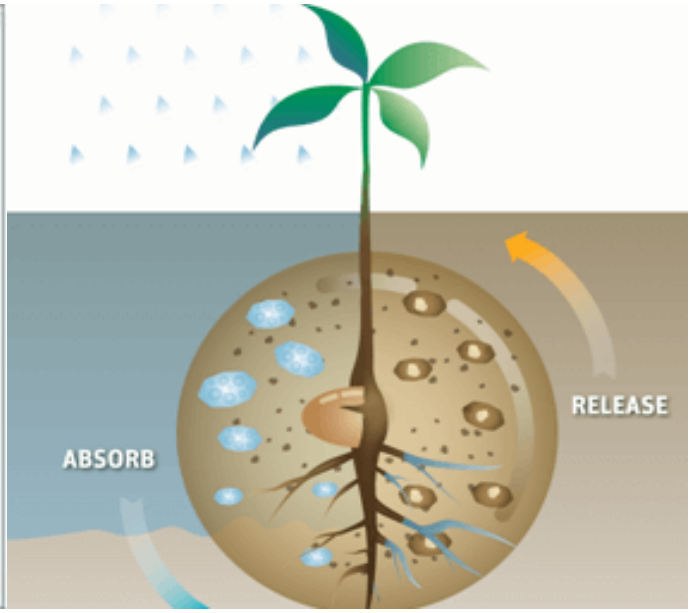
- Excellent capacity for absorption in saline and hard water environments
- Reduced soluble content and residual monomer, improved absorbency under load (AUL), and a low cost.
- Slow biodegradability without hazardous species generation; high endurance and stability in the swollen environment and during storage
- pH-neutrality after swelling in water
- Photostability
- Re-wetting potential

Hydrogel Agriculture Technology Has The Following Advantages:

- Promotes seed sprouting and seedling development, which boosts farm productivity by improving soil quality, conserving water, and reducing the effects of drought stress.
- It is non-polluting and biodegradable, aids in lowering irrigation frequency and water consumption, and offers a straightforward cyclic mechanism to deliver water directly to roots and reduce soil compaction.
- SAPs serve as miniature water reservoirs at the roots of plants in agroforestry and agriculture. They limit water loss in soil by leaching and evaporation by absorbing natural and supplied water 400–500 times their own weight and releasing it slowly due to root capillary suction mechanism.
- SAPs create a dependable, cyclical process of water absorption and release; the water so released can offer the ideal moisture for rapid germination and seedling maturity. As a result, it significantly lowers seedling mortality in nurseries.
- In cold climates, moisture freezing in and around plant root tissue frequently causes death during germination and development. Hydrogels that have absorbed moisture do not freeze and are therefore accessible to plants. Moreover, it controls the temperature of seedling growth to prevent freezing death.
- SAPs can help farmers save water and labour by reducing the frequency of irrigation, assist in drought relief efforts, serve as soil conditioners, minimise leaching in sandy soils and runoffs in mountainous and sloping fields, increase virescence effectiveness, and replenish soil biota. The compounds so absorbed with water are gradually released, extending their useful life and root system absorption efficiency.
- SAPs serve as flocculants for soil particles. They tightly bind loose soil, creating loams that may facilitate greater root latching. The repeated absorb-release mechanism simultaneously prevents over compaction of soil minerals and creates space for aeration and soil edaphon development. It has a wide range of applications in agriculture, forestry, industrial planting, municipal gardening, drought management, and water conservation. It also helps reduce soil erosion by surface run-offs, fertiliser and pesticide leaching to ground water, cost of water and irrigation, and success rate at growing crops.

Type Of Hydrogels Used in Agriculture

- A hydrogel made of starch (grafting) is both affordable and biodegradable, and its capacity to hold water may be altered. Commercially available cross-linked acrylic acid polymer hydrogels are successfully insoluble but slowly degrade to release poisonous acrylamide.
- Potassium polyacrylate comes in two different grafting types: mineral and none.
- Sodium polyacrylate, a mineral grafting substance.



Example of super absorbent polymer

Pusa Hydrogel

- To address the needs of agricultural water productivity, the Indian Agricultural Research Institute in New Delhi created the "Pusa Hydrogel" absorbent polymer.

Important characteristics of Pusa Hydrogel include:

- Natural polymer-based water absorber with a cross-linked potassium polyacrylate polymer backbone. Maximum absorbency at temperatures typical of semi-arid and arid soils.
- Less impacted by salts and stable in soil for at least a year
- Low rates of soil application (1-2 kg/ha for nursery horticultural crops; 2.5–5 kg/ha for field crops); Reduces fertiliser and pesticide leaching; Improves the physical characteristics of soils and soilless media
- Enhances seed germination and seedling emergence rates
- Enhances root growth and density and aids in the ability of plants to endure sustained moisture stress.

CONCLUSION

The properties of the soil, its capacity to store water, water retention, irrigation efficiency, crop growth, and crop water productivity all improve when hydrogel is used in dry and semi-arid locations. Moreover, it promotes better root growth in well-drained soils, which ultimately increases production. Because of their chemical and physical properties, hydrogels can be used as absorbents in the agricultural sector for water retention, soil conditioning, and nutrient transport.

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