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Hydrogel in Agricultural Farming - Alternative Source for Water Resources Conservation

***Sowmyalatha, B. S.[1] and Sahana, S. R.[2]**
Assistant Professor of Agronomy[1] and Senior Research Fellow
[1]Department of Agronomy, College of Agriculture, V.C. Farm and
[2]Junior Research Fellow, ZARS, V.C. Farm, Mandya -571 405,
University of Agricultural Sciences, Bengaluru, Karnataka, India

ARTICLE ID: 089

Hydrogel agriculture technology involves gel forming polymers that are insoluble water absorbing polymers designed exclusively for agricultural use by the late 1980's. They were developed to improve physical properties of soil to:

1. Increase water holding capacity
2. Increase water use efficiency
3. Enhance soil permeability and infiltration rate
4. Reduce irrigation frequency
5. Reduce compaction tendency
6. Stop soil erosion, farm run-off & surface leaching
7. Increase plant performance, particularly in structure-less soils stressed with drought condition

Common hydrogel agriculture's ingredient is potassium polyacrylate or sodium polyacrylate. As a superabsorbent material, it can absorb plenty water and turn water gel to store water. Hydrogels as they are commonly called are cross-linked three-dimensional networked water absorbent polymers. Three main types of Hydrogels have so far been found appropriate for agricultural use:

1. Starch-graft copolymers
2. Cross-linked Polyacrylates
3. Cross-linked Polyacrylamides & Acrylamide-acrylate copolymers

Use of Hydrogel leads to increased water use efficiency by preventing leaching and increasing frequency for irrigation. During summer months particularly in semi arid regions, lack of soil moisture can cause plant stress. Moisture released by hydrogel close to root area

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helps reduce stress and increase growth and plant performance. Hydrogels can reduce fertilizer leaching and reduce application of pesticides.

Water Absorption with Hydrogel

Hydrogel works as water reservoirs round the root mass zones of the plant. In presence of water, it expands to around 200-800 times the original volume. There is ample possibility to trap irrigation and rainwater that can then be collected, stored and gradually released for crop requirements over prolonged durations. Hydrogel mixed with soil increase soil permeability and improve germination rates. It is compatible with a wide range and type of soils and thus has in general a tendency to increase plant performance and yield.

Agriculture specific applications of Hydrogel

Hydrogel application in agriculture in terms of proposed practices and their advantages are summarized herein.

1. **Conservation in Agricultural Lands**: Addition of hydrogel polymer can increase water retention capacity of soil by 50-70% with proper amendment with various dosages of soil to hydrogel ratio. Consecutively soil bulk density can reduce by 8-10%. There is an upward trend in saturated water volumetric content of soil with increasing dose of hydrogel showing clear signs of increase in agricultural water use efficiency in arid and semi-arid regions. This has positive impact on the net plant yield. Hydrogel directly influences soil permeability, density, structure, texture, evaporation and infiltration rates of water. Irrigation frequency, compaction tendency and run-offs decrease while aeration & microbial activity is promoted. Water stress due to scarcity of moisture around root zones is often associated with premature leaf shedding, decreasing chlorophyll content, reduced seed yield, less fruit and flower yield per plant. Use of hydrogel can help moderate these impacts caused by deficit irrigation. Being a water retaining agent greatly increase irrigation period of cultivation, enhancing irrigation efficiency particularly in arid & semi-arid belts.
2. **Drought Stress Reduction**: Drought stress can lead to production of Oxygen radicals that result in increased lipid perioxidation and oxidative stress in the plants. Visible effects include stunned height, decrease in leaf area and foliar matrix damage etc. Hydrogel can reduce drought impact on plants leading to reduced stress and oxygen radical formation.

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This in turn provides scope for better growth and yield even in unfavorable climatic conditions.

3.**Enhanced Fertilizer Efficiency**: Irrigation technology has major constraints in the fields of application of fertilizers, herbicides and germicides. Studies suggest the use of synthetic fertilizers can be greatly reduced when hydrogel agriculture is practiced without hindering with crop yield and nutritional value. It would indeed be a more appropriate practice for sustainable agriculture in arid and semi-arid conditions and regions with similar ecological constrains. Moreover, potassium polyacrylate is safe and non-toxic thus prevents pollution of agro ecosystems.

4.**Biodegradability of Hydrogel Polymer**: Studies have confirmed that hydrogel is sensitive to the action of UV rays, and degrades into oligomers. The Polyacrylate becomes much more sensitive to aerobic and anaerobic microbiological degradation and can degrade at rates of 10-15% per year into water, carbon dioxide and nitrogen compounds. The hydrogel molecules are too voluminous to be absorbed into plant tissue and have zero bioaccumulation potential.

Application rates

Considering the efficiency of hydrogel in soil conditioning and moisture retention, it can be understood that an optimum mixing ratio is needed to get maximum efficacy of the method. Since the moisture holding capacity is a function of soil characteristics, dosage of hydrogel is also varied and designed based on the type of soil it is used with. A simple dosage chart has been illustrated herein but the ultimate quantity and application can only be determined after testing specific soils to be conditioned.

Type of Soil	**Suggested dosage of Hydrogel**
Arid & Semi-arid Regions	4-6 g/kg soil
For all level of water stress treatment and improved irrigation period	2.25-3 g/kg soil
To delay permanent wilting point in sandy soils	0.2-0.4 g/kg or 0.8% of soil whichever is more
To reduce irrigation water by 50% in loamy soil	2-4g/ plant pit
To improve relative water content and leaf water use efficiency	0.5-2.0 g/pot

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To reduce drought stress	0.2-0.4 % of soil
To prohibit drought stress totally	225-300 kg/ha of cultivated area
To decrease water stress	3% by weight

Hydrogel mixing with Farmyard manure and applying to soil in rows before sowing the seed