PRACTICAL APPLICATIONS OF HYDROGEL FOR IRRIGATION IN WATER SCARCE AREA

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Abstract- Water being most important and basic resource for crop production is always in high demand. The scarcity of water reflects upon photosynthesis, translocation, respiration utilization of minerals and cell division. Due to water deficiency, many draught prone areas and uneven rainfall in India, it is important to mitigate water losses and to increase efficient use of water for better yield of crops and vegetation. The water needs in India can be fulfilled in much greater potential by use of hydrogel and such super absorbent polymers.

Hydrogel is a polymer which is cross linked structure. It can absorb up to 30-40 times of its weight in pure water and then forms gel granules. It increases the water holding capacity, water efficiency, and permeability. It helps in reducing the irrigation frequency, dry density, water runoff. It can be degraded by both living and non-living environment factors. Hence practical application of hydrogel is much important in drought prone areas.

Keywords- Hydrogel, Water deficiency, Crop productivity, Soil properties

Introduction

Water scarcity in many parts of the world is a big issue of concern. The demand of food for increasing population is also increasing day by day. Therefore agriculturalists and researchers have a major role to play in this critical situation to make sufficient water available for irrigation. They are searching new techniques and methodologies for efficient utilization of applied water for the growth of crops. One such promising area in this regard is the use of hydrogels. Hydrogel is a polymer having a cross linked structure. Hydrogels are generally characterized by their ultimate capacity to absorb liquids (swelling thermodynamics), the rate at which the liquid is absorbed into their structure (swelling kinetics), as well as their mechanical property in wet or hydrated state (wet strength). Factors affecting the hydrogel properties among which, the crosslink density and the structural integrity (porosity, pore size and its distribution) have the most significant effect. Both water soluble and insoluble polymers have been marketed for agricultural use. Water-soluble polymers do not form gels and are used as soil conditioners. These include polyethylene glycol, polyvinyl alcohol, polyacrylates and polyacrylamides. Water soluble polymers were developed primarily to aggregate and stabilize soils, combat erosion and improve percolation and improve crop yield on drought and structure less soil.

Application of Hydrogel

Hydrogel has lot of applications in pharmaceutical and chemical engineering [(1)]. Hydrogels are used for producing contact lenses, hyegine products and wound dressings [(3)]. Its use for the agricultural and irrigation purpose seems to be a new area for application. The polymer of hydrogel has capability to store extra water in soil that enables crops to utilize the water over an extended period of time. Hydrogel (super absorbent polymer) is a water retaining, cross-linked hydrophilic, biodegradable amorphous polymer which can absorb and retain water at least 400 times of its original weight and make at least 95 per cent of stored water available for crop absorption. When polymer is mixed with the soil, it forms an amorphous gelatinous mass on hydration and is capable of absorption and desorption over long period of time, hence acts as a slow release source of water in soil. The hydrogel particles may be taken as "miniature water reservoir" in the soil and water will be removed from these reservoirs upon the root demand through osmotic pressure difference.

Use of hydrogels increases the amount of available moisture in root zone, thus implying longer intervals between irrigations. The effect of hydrogels is affected if they are allowed to dry out and thus irrigation is important for longevity of hydrogels. Hydrogels can be applied by either mixing with the soil or by spraying. While using the spray technique, hydrogels can be mixed with micronutrients and pesticides. Under rain fed condition, crops can better withstand drought condition without moisture stress. Improvement in seed germination, crop establishment and growth will be the consequence. This will help to ensure uniform and healthy crop stand as well as achieve high crop yield. Due to the considerable volume reduction of the hydrogel as water is released to the crop, hydrogel creates within the soil, free pore volume offering additional space for air and water infiltration, storage and root growth. Growth of roots is much better in less dense soil rather than high dense soil. The improvement of the physical soil properties like soil porosity, soil permeability and water infiltration will significantly reduce surface runoff and soil erosion, especially when soil forms semi hydrophobic crusts under compacted soil condition. The large quantities of water retained by the polymer provide extra available water to crops which facilitates better crop growth. More available water in the soil also means less frequent irrigation. Hydrogel reduces irrigation frequency of field crops. It also reduces irrigation amount from 100 to 85% of the crop water requirements and increase crop yield. The excellent water absorbency and water retention by hydrogel may prove especially practical in agriculture. It performs its wetting/drying cycles over a longer period of time, maintaining its very high water swelling and releasing capacity against soil pressure. Consequently, evaporation, deep water percolation and nutrient leaching can be avoided. Hydrogel is degraded by both living and non-living factors. It does not form any poisonous residue while degrading. Hydrogel do not change pH of water before and after swelling.

Fig 1: application of hydrogel in crop

Advantages:

1. Increase in water holding capacity of soil.
2. Increase in water use efficiency.
3. Enhance the soil permeability and infiltration rates.
4. Reduction in irrigation frequency.
5. Reduction in compaction tendency.
6. Reduction erosion and water run-off.
7. Increase in plant performance.

Limitations:

1. Complexity of application and poor distribution in soil.
2. Absorption of water is time dependent process for hydrogel.

Case Study

The Maize plant requires high water quantity and it grows in temperature about 12° C to 30°C. The environmental factors required for the growth of crop were studied and recorded for the study purpose.

In the present case study Maize crop was planted in two different pots in the same environmental conditions. In one pot, hydrogel mixed soil sample was used and in another pot, without hydrogel mixed soil sample was used. For this study locally available soil i.e. clayey soil was used. Watering was done to the crops in both the pots simultaneously and record of quantity of water applied was maintained. The quantity of water was the function of optimum moisture content of the soil at that time.

Fig 2 (a): Hydrogel mixed Soil sample

Fig 2 (b): Without Hydrogel mixed soil sample

Table 1: Observation of water quantity

Sr. No.	Watering	Volume of water (Lit)	
		Natural soil	Hydrogel mixed soil
1	First	2.5	2.5
2	Second	2.5	2.0
3	Third	2.5	1.5
4	Fourth	2.0	0

Result and discussion

Tests of time required for absorption of water by hydrogel were also performed. It was observed that in 5 minutes 75% of its capacity to absorb water was fulfilled. For 100 % of the capacity fulfillment, it took 30 minutes. More watering was needed for the soil not mixed with hydrogel.

From the study, it was observed that the hydrogel absorbed and retained water. The hydrogel is very beneficial for agricultural use. Use of hydrogel provides efficient growth of crop in minimum water quantity and it has not adverse effects on soil. Hydrogel is bio-degradable in nature.

Conclusion

Application of hydrogel was found to be very economical and beneficial for the growth of the crop under study. From the present study it is concluded that hydrogel mixed soil sample required less quantity of water as compared to that without hydrogel mixed. Similar studies under varying environmental and soil conditions can be performed for different crops. The applicability of hydrogel in water scarce area can be justified from these studies.

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