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Influence of hydrogel on growth, yield and soil properties at varied moisture regimes under drip fertigation of tomato (*Solanum lycopersicum* L.)

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Abstract
Irrigation water scarcity is one of the major limiting factors affecting crop production. The crop productivity is limited in coarse textured soils due to poor water and nutrient holding capacity attributed to leaching of applied nutrients. Hence, the use of soil conditioners such as super absorbent polymer has a tremendous potential for maximizing the water availability. A field experiment was carried out at ZARS, V.C. Farm, Mandya, Karnataka during *Kharif* 2019 to know the Influence of hydrogel on growth, yield and soil properties at varied moisture regimes under drip fertigation of tomato. The experiment was laid out in Factorial-RCBD comprised of two levels of irrigation at 0.6 and 1.0 IW/CPE along with 0, 3.7, 7.5 and 11.2 kg ha^{-1} of Pusa gel and 12.5, 25 and 37.5 kg ha^{-1} of Zeba gel. Irrigation at 1.0 IW/CPE recorded higher plant height (100.4 cm), number of branches per plant (14.3), number of leaves per plant (129.3), fruit yield (72.3 t ha^{-1}) and higher NPK use efficiency (66.4, 11 and 73.7 % respectively) as compared to Irrigation at 0.6 IW/CPE. Application of Pusa gel @ 11.2 kg ha^{-1} recorded higher plant height (103.8 cm), number of branches per plant (15), number of leaves per plant (135.8), fruit yield (73.3 t ha^{-1}) and higher NPK use efficiency (70.2, 11.8 and 76.1 % respectively) which was on par with Zeba gel @ 37.5 kg ha^{-1} and significantly higher than control (H_1). The maximum yield attributes, yield and benefit cost ratio was recorded with Pusa gel @ 11.2 kg ha^{-1} with irrigation 1.0 IW/CPE followed by with Zeba gel @ 37.5 kg ha^{-1} with 1.0 IW/CPE irrigation.

Keywords: Tomato, hydrogel and irrigation

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable grown, throughout the world. Among the vegetables, tomato ranks next to potato in world area coverage and it is generally cultivated as annual crop in India. The cultivation has been more common because of its diverse climatic adaptability and greater nutritional value. The major tomato producing nations are China, India, USA, Italy, Turkey and Egypt. Worldwide, total area under tomato is 5.04 m ha with production of 170.75 million tons and productivity of 33.99 t ha^{-1} (FAOSTAT, 2014). India contributes 11.1 per cent to total share in world and bags second position next to China. In India it is cultivated in an area of 852 thousand ha with the total production of 21,003 thousand tonnes (Anonymous 2021) [2] and the area in Karnataka is 63.73 thousand ha with production of 1419 thousand tones (Anonymous 2020) [3]. The nutritional importance of tomato is largely explained by its various health promoting compounds, including vitamins, carotenoids and phenols. The bioactive compounds have a wide range of physiological properties *viz.*, anti-inflammatory, anti-allergic, antimicrobial, vasodilatory, antithrombotic, cardio-protective and antioxidant effect. Tomato also has the naturally occurring antioxidants, vitamins C and E as well as large amounts of metabolites, such as sucrose, hexoses, citrate, malate and ascorbic acid that contributes sensory quality.

Globally, the conservation and utilization of water is the prime factor in improving the agricultural production and productivity. Water is essential for harnessing the production potential of the soil and encouraging improved crop varieties to bring maximum use of other yield enhancing factors. In this context 'Hydrogel', a novel semi-synthetic super absorbent polymer with a swelling potential of minimum 350 times, often exceeding 500 times its weight in pure water, has shown potential to realize higher yield with limited water. The polymer when mixed with the soil creates proper aeration, permeability, improves water holding capacity and increases nutrient holding capacity resulted in achieving enhanced water productivity.

Though, not much research in India has been undertaken on the use of Super Absorbent Polymer (SAP) in agriculture, many researchers over world have extensively worked on utilizing SAP for increasing water use efficiency and enhancing crop yield (Dabhi *et al.,* 2013) [15].

The production and productivity of tomato is highly seasonal and scarce commodity during summer season. The situation under rain fed, the yield and quality of tomato are limited by the availability of nutrients and water. The amount and frequency of irrigation, especially in regions with scanty rainfall or in areas where the irrigation water is scarce could be reduced with the use of hydrophilic polymers. The hydrophilic polymers can absorb water, as much as several hundred times their weight (Wallace and Wallace, 1986) [18]. The information available on combined use of polymers, with organic and inorganic fertilizers is scanty nevertheless; the beneficial effects of polymers have been studied worldwide in many horticultural crops including vegetables. The use of soil conditioners like hydrogel has an immense potential to utilize the accessible water in soil. Therefore, the present study was conducted to know the "Influence of hydrogel on growth, yield and soil properties at varied moisture regimes under drip fertigation of tomato (*Solanum lycopersicum* L.)".

Materials and Methods

A field experiment was carried out to study the performance of hydrogel on growth and yield of tomato (*Solanum lycopersicum* L.) at varied moisture regime under drip fertigation during kharif 2019 at Zonal Agricultural Research Station, V C Farm, Mandya. The experiment was laid out in Factorial-RCBD comprised of two levels of irrigation at 0.6 and 1.0 IW/CPE along with 0, 3.7, 7.5 and 11.2 kg ha^{-1} of Pusa gel and 12.5, 25 and 37.5 kg ha^{-1} of Zeba gel. The pusa gel is cellulose based grafted polyacrylamide and polyacrylate while, zebagel is starch-g-poly (2-propenamide-co-2-propenoic acid) potassium salt having similar properties with maximum absorption of water ranging from 350 to 400 g g^{-1}.

An irrigation was given through drip based on IW/CPE ratio approach, initially irrigations were given uniformly (30 mm) for better establishment on the day after transplanting (DAT) and 3rd DAT. The irrigation water requirement was calculated based on IW/CPE ratio considering one cm depth of irrigation in drip irrigation system. The irrigation water requirement = Depth of irrigation/ IW/CPE, for 1.0 IW/CPE = 1/1 = 1.0 cm and for 0.6 IW/CPE 1.0/0.6 = 1.67cm., accordingly subsequent irrigations were given at an interval of 2 to 3 days for 1.0 IW/CPE and 5 to 6 days for 0.6 IW/CPE considering the cumulative pan evaporation. The recommended dose of fertilizer is 250:250:250 kg N, P_2O_5 and K_2O ha^{-1}. The Fifty percent of phosphorus is applied to soil as basal dose and remaining phosphorus, nitrogen and potassium were supplied through fertigation scheduled twice a week. The nitrogen, phosphorus and potassium were supplied in the form of urea, mono ammonium phosphate (MAP) and muriate of potash (MOP) respectively through drip till last picking of tomato. The nutrient use efficiency was calculated as per the procedure outlined by Crasswell and Godwin, 1974, while water use efficiency was worked out from the fruit yield ha^{-1} and the amount of water supplied (Viets, 1972) [16] and expressed in kg ha^{-1} cm^{-1}. The phyco-chemical properties of soil were determined as per the protocol described by Page *et al.* (1982) [10]. The data generated from treatments imposed were subjected to analysis of variance as per the procedures outlined by Rangaswamy (2010) [11].

Results and Discussion

Effect of irrigation and hydrogel on growth parameters

Irrigation levels showed significant effect on growth parameters (Table 1). Irrigation levels of 1.0 IW/CPE recorded significantly higher plant height (100.4 cm), number of branches per plant (14.3) and number of leaves per plant (129.3) followed by Irrigation level of 0.6 IW/CPE (95.5 cm, 13.4 and 121.1, respectively). Higher water application makes increased availability moisture resulted in better crop performance compare to lower levels. Similar results were reported by Kahlon *et al.* (2007) [8].

The growth parameters were increased with increased rate of hydrogel application with respect to pusa gel and zeba gel (Table 1). Applications of pusa gel @ 11.2 kg ha^{-1} recorded significantly higher plant height (103.8 cm), number of branches per plant (15.1) and number of leaves per plant (135.8) which was on par with zeba gel @ 37.5 kg ha^{-1}. Significantly lower growth parameters were recorded with control. Application of hydrogel facilitated to retain abundant soil moisture (300 - 400 times the weight of hydrogel) and supply to the plant throughout the cropping period ensured consistent soil moisture supply and also increased adsorption of nutrients and improved nutrient availability to the crop (Silberbush *et al.,* 1993) [14]. Interaction among irrigation and hydrogel showed non-significant.

Effect of irrigation and hydrogel on yield parameters and water use efficiency

Yield parameters viz., fruit yield, fruit and haulm dry matter varied significantly with irrigation levels (Table 2). Among the two irrigation levels IW/CPE ratio of 1.0 recorded higher fruit yield (72.3 t ha^{-1}), fruit dry matter (6.5 t ha^{-1}) and haulm dry matter (2.1 t ha^{-1}). Significantly lower fruit yield, fruit and haulm dry matter was recorded with irrigation level of 0.6 IW/CPE. Positive effect on growth parameters such as number of leaves and number of branches increases the photosynthetic activity of the plant resulted in higher yield attributes. Ratio of yield to water applied was higher with IW/CPE of 1.0 compare to IW/CPE of 0.6 which resulted in higher water use efficiency in IW/CPE of 1.0 (14.5 kg ha^{-1} cm^{-1}).

Pusa gel and zeba gel showed significant effect on yield and water use efficiency. Among the hydrogel Pusa gel @ 11.2 kg ha^{-1} recorded significantly higher fruit yield (73.3 t ha^{-1}), fruit dry matter (6.6 t ha^{-1}), haulm dry matter (2.2 t ha^{-1}) and water use efficiency (13.7 kg ha^{-1} cm^{-1}) which was on par with Zeba gel @ 37.5 kg ha^{-1}. Whereas, control recorded lower fruit yield (63.7 t ha^{-1}), fruit dry matter (5.7 t ha^{-1}), haulm dry matter (1.8 t ha^{-1}) and water use efficiency (11.9 kg ha^{-1} cm^{-1}). These results in corroborate with Meena *et al.* (2011) [9] where they recorded higher yield in tomato with hydrophilic polymer compared with control. Super absorbent polymers retain large quantities of water and nutrients compared to no polymer. The adsorbed water and nutrients are released slowly as required by the crop which enhances the water and nutrient use efficiency.

Irrigation and hydrogel levels interaction showed significant effect on yield attributes. IW/CPE ratio of 1.0 with pusa gel @ 11.2 kg ha^{-1} recorded higher fruit yield (72.4 t ha^{-1}), fruit dry matter (6.5 t ha^{-1}) and haulm dry matter (2.0 t ha^{-1}) which was on par with IW/CPE ratio of 1.0 with zeba gel @ 37.5 kg

ha^{-1}. Irrigation level of 0.6 IW/CPE with control recorded lower fruit yield (58.2 t ha^{-1}), fruit dry matter (5.2 t ha^{-1}) and haulm dry matter (1.7 t ha^{-1}). Numerical increase in growth parameters resulted in higher yield parameters. Increased water application with higher rate of hydrogel stored more water and nutrients compared to lower levels of irrigation with lesser rate of hydrogel. Interaction among irrigation and hydrogel levels w.r.t. water use efficiency showed non-significant effect.

Effect on nutrient use efficiency

Nutrient use efficiency of nitrogen, phosphorus and potassium were differed significantly with the levels of irrigation and hydrogel (Table 3). Significantly higher N, P and K use efficiency (66.4, 11.0 and 73.7 %, respectively) was observed with irrigation level of 1.0 IW/CPE over irrigation at 0.6 IW/CPE (57.3, 9.6 and 63.1%, respectively). Among the levels of hydrogel, pusa gel @ 11.2 kg ha^{-1} (70.2, 11.8 and 76.1%) recorded significantly higher nitrogen, phosphorus and potassium use efficiency respectively and on par with zeba gel @ 37.5 kg ha^{-1}. Interaction effect of irrigation and hydrogel was found non-significant. Hydrogel absorbs more water and nutrients, retain for a longer period and supplies throughout the crop growing period. Due to reduced leaching of applied nutrients, production of higher biomass and yield might be attributed to increased nutrient use efficiency. Similar results were reported by El-Hady and Wanas (2006) [6]. Pusa gel is chemically cellulose based which degrade faster as compared to zeba gel which is starch based due to which pusa gel performed better resulted in higher nutrient and water holding capacity as well as water and nutrient use efficiency.

Effect on Soil physical properties

Application of Irrigation shows non-significant effect on soil physical parameters like bulk density, maximum water holding capacity, field capacity and permanent wilting point. Whereas application of hydrogel levels significantly influences the water holding capacity, field capacity and permanent wilting point (Table 3).

Maximum water holding capacity was recorded in Pusa gel @ 11.2 kg ha^{-1} (48.8 %) which was on par with Zeba gel @ 37.5 kg ha^{-1} (46.9 %) and lower water holding capacity recorded under control (40.9 %).Combined effects were found non-significant. Maximum water holding capacity was higher with hydrogel applied at higher rate due to reduction in evaporation of absorbed water from the soil (Akther *et al.*, 2004) [1].

Field capacity was higher when pusa gel was applied @ 11.2 kg ha^{-1} (23.5 %), which was on par with the zeba gel @ 37.5 kg ha^{-1} (22.9 %). Lower field capacity was recorded with control (21.6 %). Interaction effect among irrigation and hydrogel levels found to be non-significant. Permanent wilting point was higher in pusa gel @ 11.2 kg ha^{-1} (12.2 %) and was on par with zeba gel @ 37.5 kg ha^{-1} (12.1 %). Significantly lower permanent wilting point was observed in control (8.9 %). Hydrogel increases the moisture content at field capacity and permanent wilting point. The increase in water content due to its higher molecular weight that can absorb more water as much as several hundred times of its weight and act as reservoir in soil by retaining water at higher matrix potential and reducing the percolation losses (Vijayalakshmi *et al.*, 2012) [17].

Effect on soil chemical properties

The effects of irrigation and hydrogel were differed non-significantly on soil reaction, electrical conductivity, organic carbon an available nutrient status. Whereas hydrogel levels significantly influences the available nutrients (Table 4).

The soil reaction (pH) was non-significant with different irrigation and hydrogel levels. This might be attributed to the fact that all the treatments were supplied with same levels of FYM and fertilizer. Besides, hydrogel has neutral pH and does not alter the soil pH (Trung *et al.*, 2009) [15]. Electrical conductivity (dS m^{-1}) was non-significant with different levels but slightly increased electrical conductivity due to the application of hydrogel might increases the water retention capacity and also increases the nutrient holding capacity of soil. The reduction of leaching loss of basic cations viz. Ca^{2+}, Mg^{2+}, K^{+}, Na^{+} etc., ions in the soil may also contribute to higher values of electrical conductivity. The soil organic carbon content was also not influenced due to varied levels, however resulted in higher values, which also enhances the water and nutrient holding capacity. The interaction effect on soil pH, electrical conductivity, organic carbon and available nutrient status was non-significant.

Available nitrogen, phosphorus and potassium were significantly influenced by different levels of irrigation and hydrogel. Significantly higher available N (363.8 kg ha^{-1}), P_2O_5 (41.3 kg ha^{-1}) and K_2O (359.6 kg ha^{-1}) were observed under irrigation @ 0.6 IW/CPE compared to irrigation @ 1.0 IW/CPE (340.9, 38.8 and 332.9 kg ha^{-1} N, P_2O_5 and K_2O respectively). Among the levels of hydrogel, control plot recorded significantly higher available nutrient status (363.8, 42.6 and 364.1 kg ha^{-1} Av. N, Av. P_2O_5 and K_2O respectively) as compared to application of hydrogel. The availability of macro nutrients were higher in treatment where without application of hydrogel due to lesser uptake by the plant. The availability of these nutrients showed decreasing trend with increasing yield. This might be due to higher uptake of nutrients that corresponds to higher biomass production and further translocation to various plant parts including fruit, besides, being subjected to other losses. Similar findings of higher biomass production with higher nutrient uptake resulting in depleting nutrients in soil were reported by Shivakumar *et al.* (2018) [13].

Effect of irrigation and hydrogel on Economics

Economics play a crucial role to evaluate the best treatment which are economically feasible and that can be accepted by the farming community. The data are depicted in Fig 1. Higher gross returns, net returns and benefit cost ratio were recorded with irrigation level of 1.0 IW/CPE (Rs. 1108350 ha^{-1},Rs. 786987 ha^{-1} and 3.45, respectively) whereas irrigation level of 0.6 IW/CPE recorded lower gross returns, net returns and benefit cost ratio (Rs. 1073550ha^{-1}, Rs. 757187 ha^{-1} and 3.39, respectively). Lower yield parameters and nutrient use efficiency resulted in lower returns.

Among hydrogel levels, higher economics of gross returns, net returns and benefit cost ratio were recorded with pusa gel @ 11.2 kg ha^{-1} (Rs. 1100193ha^{-1}, Rs. 784375ha^{-1} and 3.48, respectively) followed by zeba gel @37.5 kg ha^{-1} (Rs. 1090950ha^{-1}, Rs. 772087ha^{-1} and 3.42, respectively). Whereas control recorded lower economics parameters (Rs. 955922ha^{-1}, Rs. 650184ha^{-1} and 3.12, respectively). Higher returns with hydrogel application compared control was also reported by Ryan *et al.* (2018) [12].

IW/CPE ratio of 1.0 with pusa gel @ 11.2 kg ha^{-1}recorded higher gross returns (Rs. 1114233ha^{-1}), net returns (795915ha^{-1}) and benefit cost ratio (3.50). Lowergross returns, net returns and benefit cost ratio recorded with the IW/CPE ratio of 0.6 with no hydrogel application (Rs. 873394 ha^{-1}, Rs. 570156 $ha^{-1}$and 2.88, respectively).

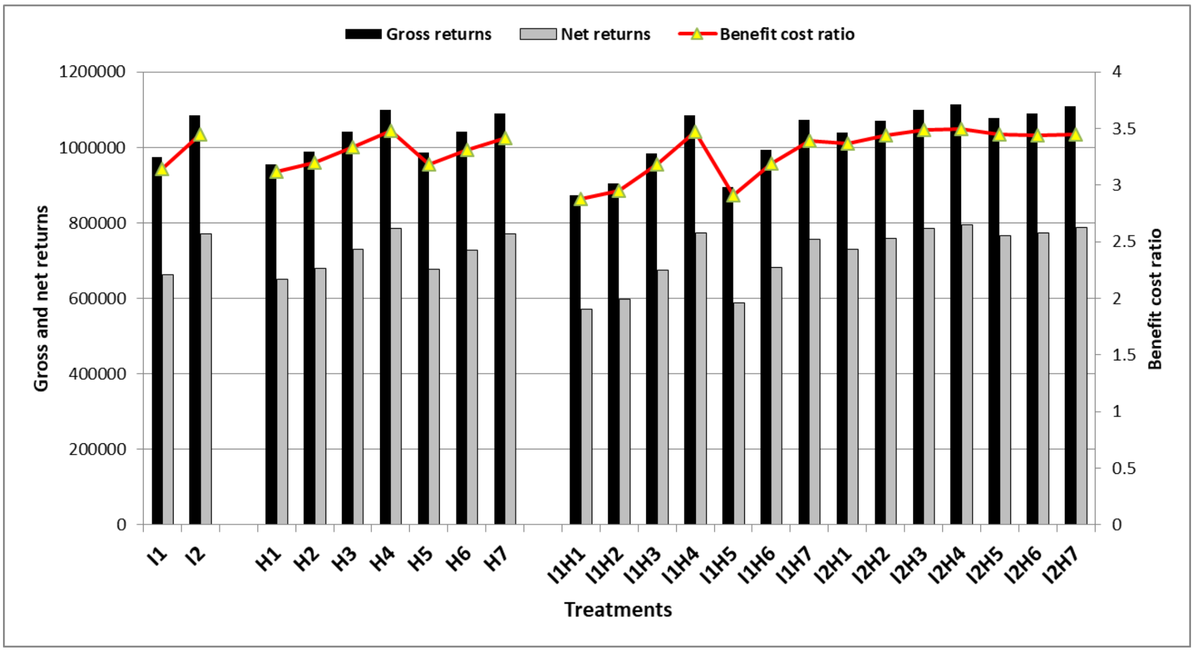

Fig 1: Economics of tomato as influenced by levels of irrigation and hydrogels.

Table 1: Growth parameters of tomato as influenced by levels of irrigation and hydrogel

Treatments	Plant height (cm)	No. of branches	No. of leaves per plant
Irrigation levels (I)			
I_1	95.5	13.4	121.1
I_2	100.4	14.3	129.3
S. Em. ±	0.69	0.12	1.11
CD (P≤0.05)	1.99	0.36	3.23
Hydrogel levels (H)			
H_1	93.5	12.9	116.4
H_2	94.7	13.3	119.9
H_3	99.3	14.2	128.3
H_4	103.8	15.1	135.8
H_5	93.8	13.1	118.3
H_6	98.3	13.8	124.9
H_7	102.2	14.7	132.9
S. Em. ±	1.28	0.23	2.08
CD (P≤0.05)	3.73	0.67	6.04
Interaction			
S. Em. ±	1.81	0.33	2.94
Interaction (I X H)	NS	NS	NS

Note:
I1: Irrigation 0.6 IW/CPE, I2: Irrigation 1.0 IW/CPE.
H1: Control, H2: Pusa gel @ 3.7 kg ha^{-1}, H3: Pusa gel @ 7.5 kg ha^{-1}, H4: Pusa gel @ 11.2 kg ha^{-1} , H5: Zeba gel @ 12.5 kg ha^{-1}, H6: Zeba gel @ 25 kg ha^{-1}H7: Zeba gel @ 37.5 kg ha^{-1}.

Table 2: Yield parameters and water use efficiency of tomato as influenced by levels of irrigation and hydrogel.

Treatments	Fruit yield (t ha^{-1})	Fruit dry matter (t ha^{-1})	Haulm dry matter (t ha^{-1})	Water use efficiency (kg $ha^{-1}cm^{-1}$)
Irrigation levels (I)				
I_1	64.8	5.8	1.9	11.2
I_2	72.3	6.5	2.1	14.5
S. Em. ±	0.57	0.05	0.02	0.13
CD (P≤0.05)	1.67	0.15	0.05	0.37
Hydrogel levels (H)				
H_1	63.7	5.7	1.8	11.9
H_2	65.8	5.9	1.9	12.3
H_3	69.5	6.2	2	13
H_4	73.3	6.6	2.2	13.7
H_5	65.8	5.9	1.8	12.3

H_6	69.4	6.2	2	13
H_7	72.7	6.5	2.1	13.7
S. Em. ±	1.07	0.10	0.03	0.18
CD (P≤0.05)	3.12	0.28	0.09	0.53
Interaction (I X H)				
I_1 H_1	58.2	5.2	1.7	10
I_1 H_2	60.3	5.4	1.8	10.4
I_1 H_3	65.6	5.9	1.8	11.3
I_1 H_4	72.4	6.5	2.0	12.5
I_1 H_5	59.7	5.3	1.8	10.3
I_1 H_6	66.2	5.9	1.8	11.4
I_1 H_7	71.5	6.4	2	12.5
I_2 H_1	69.9	6.2	1.9	13.9
I_2 H_2	71.3	6.4	1.9	14.3
I_2 H_3	73.3	6.6	2.2	14.7
I_2 H_4	74.2	6.6	2.4	14.9
I_2 H_5	71.9	6.4	1.9	14.4
I_2 H_6	72.6	6.5	2.1	14.5
I_2 H_7	73.8	6.6	2.2	14.8
S. Em. ±	1.52	0.17	0.04	0.34
CD (P≤0.05)	4.41	0.48	0.13	NS

Note:
I1: Irrigation 0.6 IW/CPE, I2: Irrigation 1.0 IW/CPE.
H1: Control, H2: Pusa gel @ 3.7 kg ha^{-1}, H3: Pusa gel @ 7.5 kg ha^{-1}, H4: Pusa gel @ 11.2 kg ha^{-1}, H5: Zeba gel @ 12.5 kg ha^{-1}, H6: Zeba gel @ 25 kg ha^{-1}H7: Zeba gel @ 37.5 kg ha^{-1}.

Table 3: Nutrient use efficiency and physical properties of soil as influenced by levels of irrigation and hydrogel

Treatments	Nitrogen use Efficiency (%)	Phosphorus use efficiency (%)	Potassium use efficiency (%)	Bulk density (Mg m^{-3})	Maximum water holding capacity (%)	Field capacity (%)	Permanent Wilting point (%)
Irrigation levels (I)							
I_1	57.3	9.6	63.1	1.39	44.8	22.3	10.6
I_2	66.4	11	73.7	1.39	44.2	22.04	11.2
S. Em. ±	0.72	0.11	0.79	0.01	0.32	0.12	0.08
CD (P≤0.05)	2.08	0.32	2.30	NS	NS	NS	NS
Hydrogel levels (H)							
H_1	55.2	9.1	61.2	1.41	40.9	21.6	8.9
H_2	58.2	9.6	64.9	1.40	42.1	21.5	10.2
H_3	63.6	10.5	70.2	1.38	46.05	23.1	11.5
H_4	70.2	11.8	76.1	1.35	48.8	23.5	12.2
H_5	57.3	9.5	63.9	1.40	41.6	20.9	10.2
H_6	62	10.3	68.6	1.39	44.9	21.4	11.21
H_7	66.5	11.3	73.7	1.40	46.9	22.9	12.1
S. Em. ±	1.34	0.21	1.48	0.02	0.96	0.48	0.24
CD (p≤0.05)	3.89	0.60	4.31	NS	2.80	1.40	0.69
Interaction							
S. Em. ±	1.89	0.29	2.10	0.03	0.86	0.31	0.20
Interaction (I X H)	NS	NS	NS	NS	NS	NS	NS

Note:
I1: Irrigation 0.6 IW/CPE, I2: Irrigation 1.0 IW/CPE.
H1: Control, H2: Pusa gel @ 3.7 kg ha^{-1}, H3: Pusa gel @ 7.5 kg ha^{-1}, H4: Pusa gel @ 11.2 kg ha^{-1}, H5: Zeba gel @ 12.5 kg ha^{-1}, H6: Zeba gel @ 25 kg ha^{-1}H7: Zeba gel @ 37.5 kg ha^{-1}.

Table 4: Physico-chemical propertiesand available nutrient statusas influenced by levels of irrigation and hydrogels

Treatments	pH	EC (dS m^{-1})	OC (g kg^{-1})	Avail. N (kg ha^{-1})	Avail. P_2O_5 (kg ha^{-1})	Avail. K_2O (kg ha^{-1})
Irrigation levels (I)						
I_1	7.4	0.22	5.4	363.8	41.3	359.6
I_2	7.3	0.22	5.5	340.9	38.8	332.9
S. Em. ±	0.13	0.004	0.009	1.79	0.40	1.98
CD (P≤0.05)	NS	NS	NS	5.20	1.15	5.76
Hydrogel levels (H)						
H_1	7.3	0.22	5.3	368.9	42.6	364.1
H_2	7.3	0.23	5.4	361.5	42.1	355
H_3	7.4	0.22	5.5	348	39.2	341.7
H_4	7.4	0.23	5.6	331.5	36.7	327.03
H_5	7.3	0.21	5.3	363.7	42.4	357.5

H_6	7.4	0.21	5.5	352.06	40.05	345.7
H_7	7.3	0.22	5.5	340.6	37.5	332.9
S. Em. ±	0.24	0.007	0.017	3.35	0.74	3.70
CD (P≤0.05)	NS	NS	NS	9.73	2.16	10.77
Interaction						
S. Em. ±	0.33	0.010	0.024	4.74	1.05	5.24
Interaction (I X H)	NS	NS	NS	NS	NS	NS

Note:
I1: Irrigation 0.6 IW/CPE, I2: Irrigation 1.0 IW/CPE.
H1: Control, H2: Pusa gel @ 3.7 kg ha^{-1}, H3: Pusa gel @ 7.5 kg ha^{-1}, H4: Pusa gel @ 11.2 kg ha^{-1}, H5: Zeba gel @ 12.5 kg ha^{-1}, H6: Zeba gel @ 25 kg ha^{-1}H7: Zeba gel @ 37.5 kg ha^{-1}.

Conclusion

It can be concluded that climate change affected the distribution of rainfall affecting the plant growth due to unavailability of moisture during critical stages, especially in dry land areas. Hence, there is a need to cultivate crops with good agricultural practices. Application of hydrogel increases maximum water holding capacity, prevent runoff and evaporation loss of water from the soil. Besides, loss of nutrient through leaching and volatilization can be prevented which in term plants are benefited for their growth and development. Based on the present investigation, application of pusagel @ 11.2 kg ha^{-1} / zeba gel @ 37.5 kg ha^{-1} was resulted in higher yield and yield attributes of tomato besides enhancing water and nutrient use efficiency.

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