Impact of hydrophilic polymer on irrigation requirement and biophysical parameters in tomato

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ABSTRACT

A field experiment was conducted during *Rabi* 2008-09 at Main Research Station College of Agriculture, University of Agricultural Sciences, Dharwad to study the impact of hydrophilic polymer on irrigation requirement and biophysical parameters in tomato. The treatments consisted of different concentrations of hydrophilic (0.50 to 1.75 g/plant) and another was control. These treatments were imposed at the time of transplanting of seedlings. The results of the investigation revealed that among the treatments the application of liquasorb (1.75 g/plant) into the soil reduced the irrigation frequency of crop as recorded in treatments T_4, T_5 and T_6 to the extent of 33 per cent less than that of control (T_7).While maximum seedling establishment (98.9%) and minimum wilting symptoms was observed with higher concentration of hydrophilic polymer. The relative water content (RWC) was also maximum in T_6 (90.2%) treatment throughout the growth period of the crop compared to the control (75%).

Meena, M.K., Nawalagatti, C.M. and ChettI, M.B. (2011). Impact of hydrophilic polymer on irrigation requirement and biophysical parameters in tomato. *Internat. J. agric. Sci.*, **7**(2): 424-428.

Key words : Hydrophilic polymer, Relative water content (RWC), Wilting symptom irrigation, Tomato

INTRODUCTION

Tomato [*Ycopersicum esculentum* (L.) Mass] is one of the most important vegetable crops grown widely all over the world. It is a self-pollinated crop and is a member of Solanaceous family with 2n = 24 chromosomes. Peru Equador region is considered to be the center of origin (Rick, 1969). English traders of East India Company introduced tomato into India in eighteenth century .Vegetables are high yielding and provide nutritional security, more employment, more cash and foreign exchange. Tomato is always in great demand to meet the requirement of kitchen and processing industry. It is one of the most popular vegetable in India accounting 6.3 per cent of total world production. To increase the yield of tomato application of minor and major nutrients is helpful as well as this can also be improved by breeding.

Nowadays hydrophilic polymer have been tried to improve growth and ultimately yield. The use of hydrophilic polymers, particular under green house condition has shown that they have great potential to hold water and release slowly for crop growth and development Polymeric soil conditioners were known since the 1950s (Hedrick and Mowry 1952). However, their wide commercial application failed even though the scientific basis for their use was quite well established. These polymers were developed to improve the physical properties of soil in view of: increasing their water-holding capacity, increasing water use efficiency, enhancing soil permeability and infiltration rates, reducing irrigation frequency, reducing compaction tendency, stopping erosion and water run-off, increasing plant performance (especially in structure less soils in areas subject to drought). When these hydrophilic polymers (hydro gel) used in correctly and in ideal situations will have at least 95% of their stored water available for plant absorption (Johnson and Veltkamp, 1985). These substances can hold 400-1500 g of water per dry gram of hydro gel and degradation in soil was found to be approximately 10% per year (Tolstikh *et al.,* 1992). In arid region of the world, hydrophilic polymer is being used quite to stabilized soil structure, which leads to increased infiltration and reduced the erosion on furrow irrigated fields (Lentz and Sojka, 1994).

MATERIALS AND METHODS

The experiment was carried out in E-block, plot No.125 belonging to Department of Crop Physiology, Main Research Station College of Agriculture, University of Agricultural Sciences, Dharwad. Tomato seedlings of variety Shakatiman were obtained from KLE nursery Pvt. Ltd., Belgaum and transplanted 31st October, 2008. The experiment was laid out in Randomized Block Design with

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three replications. The treatments involving different concentrations of hydrophilic polymer (Luquasorb) were imposed in soil at the time of transplanting of tomato. The details of all the treatments are furnished below: T_1 = Soil application of hydrophilic polymer @ 0.50 g/plant, T_2 = Soil application of hydrophilic polymer @ 0.75 g/plant, T_3 = Soil application of hydrophilic polymer @ 1.00 g/plant, T_4 = Soil application of hydrophilic polymer @ 1.25 g/plant, T_5 = Soil application of hydrophilic polymer @ 1.50 g/plant, T_6 = Soil application of hydrophilic polymer @ 1.75 g/plant and T_7 = Control

The number of seedlings survived in each plot were recorded and expressed in percentage. When the outer leaves started initiation of folding; it was taken as the symptoms of wilting initiations. Days between two successive irrigations and total number of irrigations were recorded treatments wise during the crop growth period.

The relative water content was estimated based on the method of Barrs and Weatherly (1960). The leaf discs were taken from 3rd leaf from the top of the plant and weighed to indicate fresh weight. Immediately after weighing; the leaf discs were transferred to Petri dishes containing water. After 2 to 4 hours; leaf material was surface blotted and weighed once again to indicate turgid weight. The leaf discs were then oven dried at 80°C up to 24 to 48 hours and their dry weights recorded. By using all these parameters; RWC (%) was calculated as shown below:

$$\text{RWC (\%)} = \frac{\text{Fresh weight - Dry weight}}{\text{Turgid weight - Dry weight}} \times 100$$

RESULTS AND DISCUSSION

The results obtained from the present investigation have been duscussed below:

Irrigation requirement:

The data on total number of irrigations and irrigation interval presented in Table 1 indicated differences between the treatments. The treatments T_1 and T_7 recorded more number of irrigations (6) as compared to other treatments; while T_2 and T_3 recorded less number of irrigations (5) compared to rest of the treatments (T_4, T_5 and T_6). However, the treatments T_4, T_5 and T_6 recorded more irrigation interval. The application of hydrophilic polymer reduced the irrigation frequency as was recorded in treatments T_4, T_5 and T_6 to the extent of 33 per cent less than that of control (T_7).Similarly Flannery and Busscher (1982) studied the use of synthetic polymer (Permasorb) in potting soils to improve water holding capacity in ryegrass and reported that permasorb (6.4 g/l) significantly reduced the watering frequency by increasing water holding capacity of soil. The mean number of watering was significantly reduced (20.3) in soil treated with 6.4 g/l permasorb as compared to control (32.5). Similarly Baasiri *et al*. (1986) observed the influence of polymer (Aquastock @4 kg/m^3) in cucumber which significantly reduced (28) the number of irrigations required, as compared to control (43).

Per cent seedling establishment:

The per cent seedling establishment decreased from 40 to 60 DAT in all the treatments and thereafter no further decrease was observed with T_6 recording maximum seedling establishment (98.9 %) (Table 2). It did not differ significantly with T_4 and T_5 at 60, 80 DAT, and at harvest; while there was significantly lower per cent seedling establishment in control (93.3 %). The increased water availably with the hydrogel amendments is known to improve seed germination and seedling growth (Woodhouse and Johason, 1991). Similar results were also reported by Al-Harbi *et al*. (1999) in cucumber, Akhter *et al*. (2004) in barley and wheat and Mengold and Sheley (2007) in wheatgrass (Fig. 1 and 2).

Wilting symptoms:

The wilting symptoms recorded at different stages of crop growth presented in Table 3 indicated differences between the treatments, except at early stages. No wilting symptoms were observed at transplanting and at 4 DAT.

Table 1 : Influence of hydrophilic polymer (Luquasorb) on irrigation schedule in tomato

Treatments	Irrigations details	Total number of irrigations
T_1 (HP @ 0.50 g/plant)	At transplanting, 2, 4, 14, 51 and 63 DAT	6
T_2 (HP @ 0.75 g/plant)	At transplanting, 2, 4, 51 and 63 DAT	5
T_3 (HP @ 1.00 g/plant)	At transplanting, 2, 4, 51 and 63 DAT	5
T_4 (HP @ 1.25 g/plant)	At transplanting, 2, 14 and 63 DAT	4
T_5 (HP @ 1.50 g/plant)	At transplanting, 2, 14 and 63 DAT	4
T_6 (HP @ 1.75 g/plant)	At transplanting, 2, 14 and 63 DAT	4
T_7 (Control)	At transplanting, 2, 4, 14, 51 and 63 DAT	6

DAT = Days after transplanting

Table 2 : Influence of hydrophilic polymer (Luquasorb) on per cent seedling establishment in tomato

Treatments	Days after transplanting				
	20	40	60	80	At harvest
T_1(HP@0.50 g/plant)	97.7 (81.28)	97.7 (81.28)	94.4 (76.31)	94.4 (76.31)	94.4 (76.31)
T_2 (HP@ 0.75 g/plant)	97.7 (81.28)	97.7 (81.28)	95.5 (77.75)	95.5 (77.75)	95.5 (77.75)
T_3 (HP@ 1.00 g/plant)	97.7 (81.28)	97.7 (81.28)	95.5 (81.28)	95.5 (81.28)	95.5 (81.2)
T_4 (HP@ 1.25 g/plant)	98.9 (83.98)	98.9 (83.98)	96.6 (79.37)	96.6 (79.37)	96.6 (79.37)
T_5 (HP@ 1.50 g/plant)	100.0 (90.00)	100.0 (90.00)	97.7 (81.28)	97.7 (81.28)	97.7 (81.28)
T_6 (HP@ 1.75 g/plant)	100.0 (90.00)	100.0 (90.00)	98.9 (83.98)	98.9 (83.98)	98.9 (83.98)
T_7 (Control)	96.6 (79.37)	96.6 (79.37)	93.3 (75.00)	93.3 (75.00)	93.3 (75.00)
Mean	98.5 (83.98)	98.5 (83.98)	96.0 (78.46)	96.0 (78.46)	96.0 (78.46)
S.E. (±)	0.8	0.8	0.9	0.9	0.9
C.D. (P=0.05)	NS	NS	2.8	2.8	2.8

Figures in the parenthesis are angular transformed values NS =Non-significant

Table 3 : Influence of hydrophilic polymer (Luquasorb) on wilting symptoms in tomato

Treatments	At transplanting	4 DAT	12 DAT	48 DAT	60 DAT
T_1 (HP @ 0.50 g/plant)	-	-	++	++	++
T_2 (HP @ 0.75 g/plant)	-	-	++	++	++
T_3 (HP @ 1.00 g/plant)	-	-	+	+	+
T_4 (HP @ 1.25 g/plant)	-	-	+	+	+
T_5 (HP @ 1.50 g/plant)	-	-	-	+	+
T_6 (HP @ 1.75 g/plant)	-	-	-	+	+
T_7 (Control)	-	-	+++	+++	+++

- : No wilting symptoms + : Initiation of wilting ++ : Mild wilting symptoms
+++ : Severe wilting symptoms DAT = days after transplanting

Table 4 : Influence of hydrophilic polymer (Luquasorb) on relative water content (%) at different stages in tomato

Treatments	Days after transplanting				
	20	40	60	80	At harvest
T_1(HP@0.50 g/plant)	77.9	78.5	80.5	81.2	78.7
T_2 (HP@ 0.75 g/plant)	78.0	79.7	83.5	84.8	79.8
T_3 (HP@ 1.00 g/plant)	80.8	81.7	85.7	86.4	81.2
T_4 (HP@ 1.25 g/plant)	82.6	83.9	86.3	87.3	82.2
T_5 (HP@ 1.50 g/plant)	83.9	84.1	87.6	88.7	83.9
T_6 (HP@ 1.75 g/plant)	84.3	84.4	89.3	90.2	85.3
T_7 (Control)	76.6	77.5	78.0	79.5	75.0
Mean	80.6	81.6	84.4	85.4	80.7
S.E.(±)	2.80	2.65	0.81	0.39	0.89
C.D. (P=0.05)	NS	NS	2.45	1.19	2.67

NS=Non-significant

However, at 12 DAT, T_7 recorded severe wilting symptoms, while, mild wilting symptoms were noticed in T_1 and T_2. A similar trend was observed at 48 and 60 DAT, except the treatments T_5 and T_6 which showed the initiation of wilting symptoms only at later stages of crop growth. Similarly, Abedi-Koupai *et al.* (2006) observed the effects of hydrogel (Superab A200) on the field performance of ornamental plant (*Cupressus arizonica*) under reduced irrigation regimes and concluded that the hydrogel (6 g/kg soil) increased the number of days (22 days) to reach permanent wilting point (PWP) as compared to control (12 days).

Relative water content:

The data present in Table 4 indicate that significant differences were between the treatments with respect to

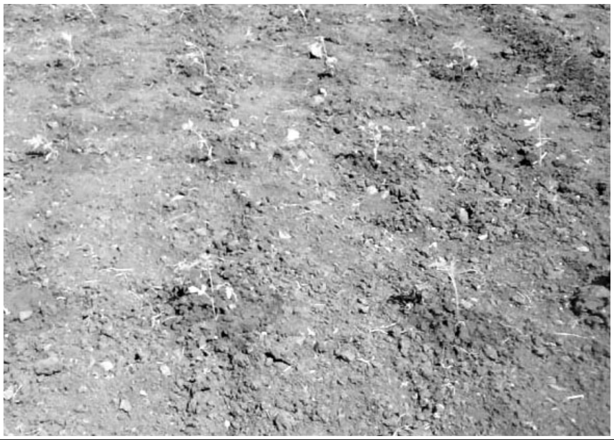

Fig. 1 : Seedlings ready for transplanting

Fig. 2 : Experimental plot of transplanted seedlings

relative water content (RWC) at all the stages. At 60 DAT, the control T_7, recorded lower RWC value (78.0%) as compared to other treatments but was at par with $T_{1.}$The treatments T_3, T_4, T_5 differed significantly with each other. A similar trend was observed at 80 DAT with T_6 recording higher RWC (90.2 %) as compared to other treatments. At harvest the control recorded the lowest RWC (75 %) and was significantly lower over all other treatments. Similarly, Volkamar and Chang (1995) also studied the influence of hydrophilic polymer (Grogel) on water relations in barley and canola and concluded that the hydrophilic polymer significantly increased (93.4%) leaf relative water content (RWC) of barley when soil treated with 1.87 g/kg polymer as compared to control (85.6%) at 47 days after planting, whereas there was no effect on canola leaf relative water content.

Conclusion:

Since irrigation water is a limiting factor in the country; it is important to improve the water use efficiency of the plants. The use of water retaing polymers has potential for horticultural and other crops. The results of this study have shown that the crop yield could be improved by adding hydrophilic polymer to the soil as the polymer in soil can store extra water and enable to the plants to utilize that water over an extended period of time.

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Received : March, 2011; Accepted : May, 2011