Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 1343-1346
Received: 29-01-2018
Accepted: 30-02-2018

Parameshwarareddy R
Ph.D Scholar (Agronomy), University of Agricultural Sciences, Dharwad, Karnataka, India

SS Angadi
Professor of Agronomy, University of Agricultural Sciences, Dharwad, Karnataka, India

MS Biradar
Assistant Professor of Horticulture, University of Agricultural Sciences, Dharwad, Karnataka, India

RH Patil
Assistant Professor of Agronomy, University of Agricultural Sciences, Dharwad, Karnataka, India

Correspondence
Parameshwarareddy R
Ph.D Scholar (Agronomy), University of Agricultural Sciences, Dharwad, Karnataka, India

Water productivity of tomato as influenced by drip irrigation levels and substrates

Parameshwarareddy R, SS Angadi, MS Biradar and RH Patil

Abstract
The pot experiment was conducted at the Hi-tech Horticulture unit at Saidapur Farm, MARS, UAS, Dharwad during *rabi* 2015-16. The results indicated that, the total water requirement for tomato under polyhouse condition using drip irrigation levels at 50,75 and 100 percent pan evaporation (PE) were 20.83, 29.24 and 37.65 l plant^{-1} respectively. Among drip irrigation levels 50 percent PE recorded significantly highest water productivity (74.56 kg m^{-3}) and least in 100 percent PE (67.56 kg m^{-3}). Within substrates treatment, mixed substrates of cocopeat + perlite + vermiculite at 50:25:25 recorded significantly higher water productivity (83.37 kg m^{-3}) as compared to others.

Keywords: tomato, substrates, drip, irrigation levels, productivity

Introduction
Today our aim is to increase the agricultural production per unit volume of water, per unit cropped land in a unit time. The slogan of the day "more crop per drop" more appropriately emphasizes the same. Scientific management of irrigation water provides the insurance against weather induced fluctuation in total production. This is the only way in which we can make our agriculture competitive and profitable.

The present investigation assumes significance in view of the fact that water, as a resource in agriculture, has become limiting factor in arid and semi-arid regions. The agriculture and horticulture activities are heavily dependent on irrigation water which has become most precarious as rainfall distribution during the rainy season in this region is uncertain and erratic. Hence better management of available water resources through more efficient methods of water application like drip irrigation under condition of protected cultivation assumes great significance in enhancing the yield and water productivity.

The drip system offers an opportunity for application of water soluble fertilizers and thus reduces loss of nutrients and water. Furthermore, different water regimes obtained by combining amount of water and irrigation interval give useful indications on the possibility of improving nutritional quality of tomato by reducing irrigation water applied during tomato cultivation. The work on use of soilless media and judicious use of water to high value crops is meager. Hence, the present investigation was carried out to evaluate the water productivity tomato as influenced by drip irrigation levels and substrates under green house condition.

Material and Methods
The pot experiment was conducted at the Hi-tech Horticulture unit at Saidapur Farm, MARS, UAS, Dharwad which is situated in the Northern Transition Zone (Zone 8) in Karnataka state. STH -801 tomato cultivar was raised in a naturally ventilated polyhouse. The growing system designed for this particular study was earthen pots of size 8.5 l capacity. Three different inert growing media combinations were used for the experiment and soil was used as check. The treatment (twenty four) comprised the combination of drip irrigation (I_1: 50 percent of pan evaporation I_2: 75 percent of pan evaporation I_3: 100 percent of pan evaporation) as factor-I and medias (M_1: Cocopeat, M_2:Perlite, M_3:Vermiculite, M_4 Cocopeat + Perlite (50:50) – (1:1), M_5: Cocopeat + Vermiculite (50:50) – (1:1), M_6: Cocopeat + Perlite + Vermiculite (50:25:25)– (2:1:1), M_7: Sole soil (Grown in earthen pot) M_8: Sole soil (Grown under normal condition) as factor –II.

Seedlings were transplanted at recommended spacing at a shallow depth of 2 to 2.5 cm. Plants were watered every day with hose pipe with rose head can immediately after transplanting until the plants established and then irrigated with drip irrigation as per the treatment. The main and sub-main pipelines used for drip irrigation were made of PVC pipes of 63 and 40 mm diameter respectively.

Linear low density polyethylene (LLDPE) pipes of 12 mm diameter were used as laterals in drip irrigation treatments. The drippers of 1.5 litres per hour (lph) capacity were fitted on the laterals at a spacing of 40cm.

Water requirement of tomato

The quantity of irrigation water applied to various treatments was based on daily pan evaporation reading. The evaporation inside the polyhouse was observed by using USWB Class - A open pan evaporimeter. The irrigation treatments were imposed after the seedlings were established and the total water requirement for tomato was obtained by adding the total amount of water applied to each treatment.

The daily water requirement for drip irrigation was computed by using the data from USWB Class - A open pan evaporimeter. The crop coefficients and foliage factor values used at different crop growth stages were presented in Table 1.

Table 1: Stage wise crop coefficient and crop foliage factors considered to workout water requirement of tomato

Crop stage	Duration (days)	Period	Crop coefficient (C value)	Crop foliage factor (B value)
Initial	20	November 29 – December 18, 2015	0.28	0.40
Development	30	December 19 – January 17, 2016	0.90	0.50
Mid - season	40	January 18 – February 26, 2016	1.18	0.85
Late - season	30	February 27 – March 27, 2016	0.43	0.93

The crop coefficients for tomato used in the study were given by Manohar *et al.* (2000) [5], which were varied from 0.28 to 1.18. The foliage factors (ratio of the plant canopy area to the area earmarked per plant as per the recommended spacing) used were in the range from 0.40 to 0.93 for tomato during the crop period. The water requirement of tomato plant per day under drip irrigation was computed by using the following equation:

$$Q = A \times B \times C \times D$$

Where,
Q = Quantity of water required per plant, lpd (litre per day)
A = Gross area per plant, m2
B = Amount of area covered with foliage, fraction
C = Crop coefficient, fraction
D = Kp × Epan
Where,
Kp = Pan coefficient, fraction
Epan = Evaporation from class – A pan evaporimeter, mm

The value of pan co-coefficient was taken as 0.7 for converting the observed pan evaporation for use in study (Michael, 2009).

Duration of irrigation

The quantity of water to be applied was computed every day as explained above. The discharge rate of the emitters, duration of irrigation water applications were calculated by using the following formula

$$\text{Duration of irrigation} = \frac{\text{Quantity of water to be applied (l)}}{\text{Average discharge of emitters (lph)}}$$

The average emitter discharge rate was calculated by taking the mean of the discharges of all emitters in a treatment.

Water productivity

The water productivity of each treatment was computed by using following formula

$$\text{Water productivity (kg m}^3\text{)} = \frac{\text{Yield (kg ha}^{-1}\text{)}}{\text{Water applied (m}^3\text{ ha}^{-1}\text{)}}$$

Results and Discussion

Month wise daily average quantities of water used by a plant (average of monthly basis) under various levels of drip irrigation are presented in Table 2.

Table 2: Month wise daily average amount of water applied per plant (lpd plant^{-1}) under different drip irrigation levels

Month	Daily average amount of water applied (lpd plant^{-1})		
	50%PE	75% PE	100% PE
December	0.044*	0.066*	0.087*
January	0.129	0.194	0.259
February	0.250	0.374	0.499
March	0.138	0.207	0.276
April	0.084	0.126	0.168

***** Excludes the amount of water applied before transplanting of tomato. PE: Pan Evaporation

It varied from 0.044 lpd plant^{-1} in December to 0.250 lpd plant^{-1} in March at 50 percent PE, similarly it was 0.066 lpd plant^{-1} in December to 0.374 lpd plant^{-1} in March in case of 75 percent PE and for irrigation at 100 percent PE, ranged from 0.087 lpd plant^{-1} in December to 0.499 lpd plant^{-1} in March.

Similarly, month wise total amount of water applied per plant under different levels of drip irrigation is presented in Table 3. The monthly water requirement with drip irrigation at 50 percent PE, varied from 1.22 l plant^{-1} (5.10 mm ha^{-1}) in December (27 days only) to 7.24 l plant^{-1} (30.14 mm ha^{-1}) in March and for 75 percent PE, the same varied from 1.84 l plant^{-1} (7.65 mm ha^{-1}) in December to 10.86 l plant^{-1} (45.23 mm ha^{-1}) in March. Similarly, the drip irrigation level at 100 percent PE ranged from 2.45 l plant^{-1} (10.20mm ha^{-1}) in December to 14.47 l plant^{-1} (60.31 mm ha^{-1}) in March.

Table 3: Month wise total amount of water applied (l plant^{-1}) under different drip irrigation levels

Month	Amount of water applied (l plant^{-1})		
	50%PE	75% PE	100% PE
Pre planting	4.00(16.67)	4.00(16.67)	4.00(16.67)
December	1.22(5.10)	1.84(7.65)	2.45(10.20)
January	4.01(16.70)	6.01 (25.06)	8.02(33.41)
February	7.24(30.15)	10.86(45.23)	14.47(60.31)
March	4.27(17.80)	6.41(26.71)	8.55(35.61)
April	0.08(0.35)	0.13(0.52)	0.17(0.70)
Total	20.83(86.78)	29.24(121.83)	37.65(156.89)

Figures in parenthesis indicate the quantity of water applied as expressed in depth over 1 ha i.e. mm ha $^{-1}$. PE: Pan Evaporation

The total water requirement of tomato under different treatments of 50, 75 and 100 percent pan evaporation (PE) was 20.83, 29.24 and 37.65 l plant^{-1} respectively. Similar findings were reported by Harmanto *et al.* (2005) [3]. They

noticed that, tomato plants with 100% of ETc received a total of about 44 l of irrigation water during the growing season. Similarly, for 75 percent of ETc, 50 percent of ETc and 25 percent of ETc treatments the irrigation water applied were 33, 22 and 11 l, respectively, during the entire growing period. The total seasonal water requirement of tomato was 86.78, 121.83 and 156.78 mm ha^{-1} for drip irrigation at 50, 75 and 100 percent PE respectively (Table 3). Increase in the levels of drip irrigation helped for increasing the yield per hectare by 63.36 percent in drip irrigation at 100 percent PE and 34.10 percent in drip irrigation at 75 percent PE as compared to drip irrigation at 50 percent PE. Drip method of irrigation proved appropriate to schedule irrigation to tomato in polyhouse. The daily water requirement of tomato fluctuated during growing season and was in accordance with the microclimate on a respective day and growing stage of plants.

Table 4: Crop stage wise daily average and total amount of water applied under different drip irrigation levels

Crop stage	Daily average amount of water applied (l $plant^{-1}$)			Crop stage wise amount of water applied (l $plant^{-1}$)		
	50%PE	75% PE	100% PE	50%PE	75% PE	100% PE
Pre planting	4.00	4.00	4.00	4.00	4.00	4.00
Initial	0.018	0.027	0.037	0.366	0.549	0.732
Development	0.097	0.145	0.193	2.895	4.343	5.791
Mid season	0.244	0.366	0.489	9.773	14.660	19.546
Late season	0.126	0.190	0.253	3.792	5.689	7.585
Total				20.83	29.24	37.65

PE: Pan Evaporation

The values of the average daily and crop stage wise amount of water applied at different levels of drip irrigation are presented in Table 4. The results revealed that the average daily consumptive use of water for all PE levels was minimum during initial stage and maximum during mid season stage. It ranged from 0.018 to 0.244, 0.027 to 0.366 and from 0.037 to 0.489 l $plant^{-1}$ at 50, 75 and 100 percent PE respectively.

Similarly, water applied at 50 percent PE was lowest (0.366 l $plant^{-1}$) during initial stage, while the highest (9.773 l $plant^{-1}$) was in the mid season. It varied from 0.549 l $plant^{-1}$ in the initial stage to 14.660 l $plant^{-1}$ in the mid season stage for 75 percent PE. Similarly, it was 0.732 to 19.546 l $plant^{-1}$ for 100 percent PE during the above stages.

Water productivity (kg m^{-3})

It is absolutely necessary to realize the importance water as a scarce natural resource, although renewable by natural ways. Water productivity in general indicates the efficiency of crops in utilizing the water. A crop consuming less water with higher yield is more efficient than crop consuming less water with low yield potentiality can result in poor water use efficiency. Water productivity not only related to water used but also yield in proportion to water used. Hence, any parameter to achieve higher yield or any parameter that can reduce the water consumption can increase water productivity.

Table 5: Water productivity (kg m^{-3}) of tomato fruits as influenced by drip irrigation levels and different substrates

Treatment	Water productivity (kg m^{-3})			
I / M	I_1	I_2	I_3	Mean
M_1	76.39	75.31	69.87	73.86
M_2	77.40	75.08	69.56	74.01
M_3	79.87	77.27	70.17	75.77
M_4	82.01	79.88	74.91	78.94
M_5	80.40	78.85	75.43	78.23
M_6	86.55	82.81	80.76	83.37
M_7	55.77	43.72	43.14	47.54
M_8	58.12	56.94	56.12	57.06
Mean	74.56	71.23	67.50	
	I	M	I X M	
S.Em±	0.95	1.55	2.69	
C.D. at 1%	3.60	5.88	NS	

I: Irrigation level - I_1: Once a day at 50 percent of pan evaporation, I_2 : Once a day at 75 percent of pan evaporation, I_3 : Once a day at 100 percent of pan evaporation, M: Media - M_1:Cocopeat, M_2: Perlite, M_3 : Vermiculite, M_4: Cocopeat + Perlite (50:50), M_5: Cocopeat + Vermiculite (50:50) M_6: Cocopeat + Perlite + Vermiculite (50:25:25), M_7: Sole soil (Grown in earthen pot), M_8: Sole soil (Grown under normal condition) and NS: Non significant

In the present investigation, drip irrigation levels had a significant influence on water productivity (WP) of tomato. Drip irrigation at 50 percent PE recorded (Table 5) significantly higher WP (74.56 kg m^{-3}) as compared to others. However, it was on par with drip irrigation at 75 percent PE (71.23 kg m^{-3}). This might be due to efficient use of water at lower amount of irrigation than at higher amount of water applied. The results are in conformity with the findings of Sezen *et al.* (2010) and Dunage (2009) [7, 1].

Similarly, substrates had a significant effect on WP of tomato. Mixed substrates with cocopeat + perlite + vermiculite at 50:25:25 recorded significantly higher WP (83.37 kg m^{-3}) as compared to others. However, it was on par with cocopeat + perlite at 50:50 (78.94 kg m^{-3}) and cocopeat + vermiculite at 50:50 (78.23 kg m^{-3}).This might be due to higher yield and precise water use by tomato. The interaction effects due to drip irrigation levels and substrates did not differ significantly among various treatment combinations.

References

1. Dunage VS, Balakrishnan P, Patil MG. Water use efficiency and economics of tomato using drip irrigation under net house conditions. Karnataka J Agric. Sci., 2009; 22(1):133-136.
2. Eliades G. Irrigation of greenhouse grown cucumbers. J Hort. Sci., 1988; 63(2):235-239.
3. Harmanto, Salokhe VM, Babel MS. Water requirement of drip irrigated tomatoes grown in greenhouse in tropical environment. Agric. Water Mngt. 2005; 71:225-242.
4. Ismail SM, Ozawa K, Khondaker NA. Effect of irrigation frequency and timing on tomato yield, soil water dynamics and water use efficiency under drip irrigation. Eleventh Int. Water Technol. Conf., IWTC11, Sharm El-Sheikh, Egypt, 2007, 69-84.
5. Manohar N, Nagaraja K, Patil MG. Evaporation and consumptive use of different crops part –II (Vegetable crops). Karnataka J. Agric. Sci., 2000; 13(2):384-388.
6. Michael AM. Irrigation Theory and Practices, Vikas Publishing House Pvt. Ltd., 2009, 514.
7. Sezen SM, Celikel G, Yazar A, Tekinand S, Kapur S. Effect of irrigation management on yield and quality of tomatoes grown in different soilless media in a glasshouse. Sci. Res. and Essay 2010; 5(1):41-48.
8. Tuzel H, Ul MA, Tuzel Y. Effects of different irrigation intervals and rates on spring season glasshouse tomato production: I. Yield. Acta Hort. 1994a; 366:381-388.
9. Tuzel Y, Ul MA, Tuzel H. Effects of different irrigation intervals and rates on spring season glasshouse tomato production: II. Fruit quality. Acta Hort. 1994b; 366:389-392.