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Short Communication

OPTIMUM INTERVAL OF IRRIGATION FOR GREEN CHILLI GROWN IN REDDISH BROWN EARTH SOILS (*RHODUSTALF*)

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INTRODUCTION

Other field crops (OFCs) are raised in a considerable land extent under supplementary irrigation in irrigable lands during *yala* season (Kendaragama and Bandara, 2000). Chilli (*Capsicum annuum* L.) is one of such important OFC cultivated in large extents. The trend of chilli cultivation has been drastically changed into green chilli production from dry chilli production due to the financial benefits. However, there is a large gap between the potential green chilli yield (> 25 t/ha) (FCRDI, 2012) and the average green chilli yield (4-5 t/ha) (Agstat, 2013) due to number of abiotic and biotic stresses in crop growing environments. One of the key abiotic factors attributed for the yield gap is soil moisture stress. Presently average irrigation interval in Mahaweli irrigation system is around 7 to 10 days.

Reddish Brown Earth (RBE, *Rhodustalf*) is the most common great soil group in the Dry Zone found in upper and the middle aspects of the undulating landscape. This soil group is hence widely used for cultivation of OFCs including chilli under rain fed conditions or with supplementary irrigation (Kendaragama, 2010). The objective of this study was to determine the optimum irrigation interval for chilli, and to assess the yield losses due to soil moisture stress caused by increased irrigation interval in RBE soils. Upgrading the information available on crop water requirement of chilli under irrigated condition, was another objective.

MATERIAL AND METHODS

The experiment was carried out both at the Field Crops Research and Development Institute (FCRDI), Mahailluppallama (08^{0}06'40.54" N and 80^{0}28'14.70 E) and at the Grain Legumes and Oil Crops Research and Development, Centre (GLORDC), Angunakolapellessa (06^{0}08'55.00" N and 80^{0}54'20.50 E) in 2012 *yala.* Experimental sites were located on well drained RBE soils. Both locations are in DL1b agro-ecological region (Punyawardena, 2008).

An evaporation pan and rain gauge were established near the experimental site to obtain daily evaporation and rainfall data, respectively. Irrigation interval treatments were set as 3, 6, 9 and 12 days. The amount of irrigation for each interval was calculated based on climatological approach using the crop coefficients (Kc) for chilli and daily evapotranspiration data using the following equations by Allen *et al.* (1998).

$$\text{Irrigation water requirement for an interval} = \frac{\text{Crop water requirement for the interval}}{\text{Application efficiency (as a fraction)}}$$

Crop water requirement for an interval = $Kc \times ET_0$

Where,

Kc = Crop coefficient with respect to the growth stage

ET_0 = Cumulative evapotranspiration for the interval

= Cumulative pan evaporation x Pan factor (Pan factor was taken as 0.7)

Application efficiency was taken as 0.4 (area, unpublished data). The cumulative irrigation amount for the crop duration was a constant for all the treatments.

The treatments were allocated in 3.6 m x 2.7 m plots in RCBD with three replicates. Plants of the chilli variety 'KA 2' at Mahailluppallama and 'MI 2' at Angunakolapellessa were transplanted in raised beds. Cattle manure was incorporated at the rate of 10 t/ha as a organic manure source to all plots. Other agronomic management practices were practiced according to the recommendations of the Department of Agriculture (Karunathilaka, 2011). Soil moisture was determined gravimetrically at 0-20 cm and 20-40 cm depth classes prior to each irrigation and daily rainfall and pan evaporation data were recorded. Soil bulk densities of both depth classes were measured to calculate volumetric water content of the two depth classes of soil using the following equation based on Allen *et al.* (1998).

Volumetric water content = Gravimetric water content x Bulk density

The soil volumetric moisture contents at the field capacity (FC) and the permanent wilting point (PWP) were taken as 28% and 16%, respectively (Joshua, 1988), in soil moisture depletion calculations using the following equations based on Allen *et al.* (1998).

Available volumetric soil moisture % = Volumetric soil moisture % at FC - Volumetric soil moisture % at PWP

Soil moisture depletion (%) =

$$\frac{\text{(Volumetric water \% of soil at FC - Volumetric water (\%) of soil)}}{\text{Available soil moisture (\%)}} \times 100$$

The irrigation water use efficiency (IWUE) was calculated by the following equation.

$$\text{IWUE} = \frac{\text{Mean yield (g)/ Area (m}^2\text{)}}{\text{Irrigated cumulative amount of water (mm)}}$$

The soil moisture conditions of all the treatments were brought to the field capacity at the initial stage prior to the irrigation.

RESULTS AND DISCUSSION

Growth and the yield parameters with respect to the tested irrigation intervals are given in the tables (Table 1 and table 2).

Table 1: Growth and yield performances of chilli crop with respect to the irrigation interval treatments at Mahailluppallama.

Treatments	Mean canopy diameter (cm)*	Mean plant height (cm)*	Mean green chilli yield (t/ha)**	Mean IWUE (g/m²/mm)**
3 days interval	56 a	49 a	28.4 ab	2.2 ab
6 days interval	55 a	44 a	31.4 a	2.5 a
9 days interval	43 b	37 b	24.6 bc	1.9 bc
12 days interval	45 b	36 b	22.0 c	1.7 c
LSD	10.0	5.0	6.2	0.5
CV (%)	10.0	6.0	11.6	11.6

Notes: Means followed by the same letters are not significantly different at p = 0.05. * at 1st harvesting, ** from 12 picks (4 months).

Table 2: Growth and yield performances of chilli crop with respect to the irrigation interval treatments at Angunakolapellessa

Treatments	Mean canopy diameter (cm)*	Mean plant Height (cm)*	Mean green chilli yield (t/ha)**	Mean IWUE (g/m²/mm)**
3 days interval	38.71 a	23.4 a	6.19 a	1.58 a
6 days interval	39.81 a	24.8 a	7.10 a	1.82 a
9 days interval	35.26 b	21.2 b	4.47 b	1.14 b
12 days interval	31.09 b	19.8 b	2.86 c	0.73 c
LSD	3.4	3.2	1.1	0.4
CV (%)	7.7	5.8	6.3	4.3

Notes: Means followed by the same letters are not significantly different at p = 0.05. * at 1st harvesting, ** from 05 picks (3 months).

The plant canopy diameter and the plant height at the 1st harvesting were significantly higher in 3 and 6 days irrigation interval compared to 9 and 12 days irrigation intervals at both locations (Tables 1 and 2). The green chilli yield of all treatments was affected by the pest and disease incidences at Angunakolapelessa after 3 months (after 5 picks). Therefore, cumulative yield up to the 5th pick was only taken into account at Angunakolapellessa. The cumulative green chilli yield of the growing period and the IWUE of the treatment with 6 days interval were significantly higher to those of the treatments with 9 and 12 days irrigation intervals. Behaviour of two cumulative yields were similar in the treatments with 3 and 6 days irrigation intervals at both locations (Tables 1 and 2). However, based on the higher labour involvement and water requirement at higher frequency in the treatment of irrigation interval with 3 days, the irrigation interval with 6 days will be more beneficial. Nayakakorala (1993) has also reported that the chilli crop should be irrigated once in 5 days during the first month of growth and in weekly interval thereafter.

Mean cumulative green chilli yield was reduced by 22% (6.8 t/ha) with the increase of irrigation interval from 6 days to 9 days at Mahailluppallama whereas, the reduction was 37% (2.6 t/ha) at Angunakolapellessa. The mean irrigation water use efficiency was significantly reduced by 24% (0.6 $g/m^2/mm$) with the increase of irrigation interval from 6 days to 9 days at Mahailluppallama whereas, the significant reduction was 37% (0.7$g/m^2/mm$) at Angunakolapellessa for the same. The cumulative crop water requirement and the cumulative irrigation water requirement for 4 months (May-September) was 535 mm and 1,290 mm, at Mahailluppallama whereas it was 390 mm and 947 mm, for 3 months (May-August) at Angunakolapellessa. Nayakakorala (1993) also showed that the crop water requirement of chilli when grown in DL1 agro-ecological region during *yala* (May-September) could be considered around 585 ± 65 mm.

The bulk density of the depth class 0-20 cm and 20-40 cm were 1.61 Mg/m^3 and 1.68 Mg/m^3, at Mahailluppallama whereas, those were 1.56 Mg/m^3 and 1.64 Mg/m^3, at Angunakolapellessa. Average soil moisture contents and the soil moisture depletion levels with respect to the tested irrigation intervals are given in the table (Table 3). The average volumetric soil moisture content and the average volumetric soil moisture depletion level at both sites with respect to the 6 days irrigation interval were 22.5 % and 46 %, respectively.

CONCLUSIONS

Six days irrigation interval is the best among the tested 3 days, 6 days, 9 days and 12 days intervals of irrigation for optimum growth and yield performances of green chilli in well drained RBE soil. Increased interval of irrigation from 6 days to 9 days will result

in reduction in green chilli yield and irrigation water use efficiency by around 28-30 %. Cumulative crop water requirement of green chilli crop of 4 months is around 530 mm whereas, it is around 390 for green chilli crop of 3 months in the *yala* season in DL1b agro-ecological region.

Table 3. Average soil moisture contents and depletion levels with respect to the irrigation interval treatments.

Treatment	Mahailluppallama		Angunakolapellessa	
	Average volumetric soil moisture (%)*	Average volumetric soil moisture depletion (%)*	Average volumetric soil moisture (%)*	Average volumetric soil moisture depletion (%)*
3 days interval	26	20	25	27
6 days interval	23	40	22	52
9 days interval	21	54	20	69
12 days interval	19	79	16	99

Note: *average of 0-20 cm and 20-40 cm depth classes.

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