Research article

Effects of Drip Irrigation Frequency on Growth and Yield of Melon (*Cucumis melo* L.) under Net-house's Conditions

NARETH NUT*
Faculty of Agricultural Engineering, Royal University of Agriculture, Phnom Penh, Cambodia
Email: nnareth@rua.edu.kh

KUNTHEA PHOU
Faculty of Agricultural Engineering, Royal University of Agriculture, Phnom Penh, Cambodia

MACHITO MIHARA
Faculty of Regional Environment Science, Tokyo University of Agriculture, Tokyo, Japan

SALAN NUTH
Department of Foundation Year, Royal University of Agriculture, Phnom Penh, Cambodia

SANTY SOR
Department of Agricultural Engineering, Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia

Received 11 February 2019 Accepted 24 May 2019 (*Corresponding Author)

Abstract Irrigation plays an important role in melon (*Cucumis melo* L.) production. The study was conducted to compare the influence of irrigation frequency on growth and yield of melon and to identify the irrigation water use efficiencies of each treatment. The experimental plot was designed in RCBD layout divided into four treatments with three replications. They were Treatment 1 (T1), irrigated by drip irrigation 1 time per day, Treatment 2 (T2) irrigated by drip irrigation 2 times per day, Treatment 3 (T3) irrigated by drip irrigation 3 times per day, and Treatment 4 (T4) irrigated by hand-watering 2 times per day. All treatments were applied with the same amount of irrigation water based on crop water requirement calculation. Statistical analysis was done by ANOVA in SPSS software. The results indicate that T3 significantly affected on vegetative development (plant height and plant diameter), water use efficiency (WUE), dried and wet mass and yield of melon. The highest yields were obtained from T3 of 46.75 tons/ha with WUE of 78.18 kg m^{-3}, while the plant height and plant diameters were 164.33 cm and 10.55 mm and the lowest at the T4 of 29.17 tons/ha with WUE of 51.98 kg m^{-3}, while the plant height and plant diameters were 148.33 cm and 9.63 mm. However, there were no significant differences in water use efficiency between T1, T2 and T4 which are 55.60 kg m^{-3}, 64.10 kg m^{-3} and 51.98 kg m^{-3}, respectively. Therefore, based on vegetative development, yield and quality of melon, T3 treatment would be the most appropriate irrigation for melon growers in controlled conditions.

Keywords drip irrigation, frequency, growth, melon, water use efficiency, yield

INTRODUCTION

Irrigation plays an important role to increase the crop yield or crop productivity (Nut et al., 2017), especially inside greenhouse (Li et al., 2012). The proper irrigation frequency is vital in improving the water use efficiency and the productivity by applying the required amount of water when it is needed. On the other hand, the poor irrigation frequency can lead to the development of crop water deficit and result in a reduced yield due to water and nutrient deficiency. Water saving and higher water use efficiency will be significant factors in agricultural production. In most cases from agronomic, water conservation and economic aspects, drip irrigation has many advantages for crop production, particularly under protected culture condition (Ertek et al., 2006; Kumar et al., 2007;

Fernandez et al., 2007; Nut et al., 2017). Compared with furrow irrigation, drip irrigation can irrigate the crop root from the topsoil to increase water use efficiency.

Melon (*Cucumis melo* L.) is an important horticultural crop in the world, and is often cultivated with irrigation in semiarid or arid regions (Li et al., 2012). In Cambodia, tens of thousands of melons are grown every year by local farmers on increasing local demand. Some research has shown that melon is sensitive to water stress as the water deficit can reduce fruit yield and quality (Fabeiro et al., 2002). From seed sowing to emergence, excessive soil water can damage melon and cause fruit quality problems (Sensoy et al., 2007). At the same time, the relatively shallow depth of melon roots require soil water to be maintained at a minimum of 65% of capacity in order to avoid water deficit (Sensoy et al., 2007). Excessive irrigation immediately after transplantation can result in long and coarse growth, underdeveloped flower stalks and premature flower death of some plants such as squash, cucumber, watermelon and melon (Fabeiro et al., 2002; Kirnak et al., 2005; Ertek et al., 2006). Therefore, irrigation should be scheduled to avoid excessive water that can lead to reduced yield, lower quality, lower irrigation water use efficiency (IWUE), plant disease and fruit deformation in field or inside greenhouse (Sensoy et al., 2007).

OBJECTIVE

The research aims: 1). To compare the influence of irrigation frequency on growth and yield of melon and 2). To identify the irrigation water use efficiencies of each treatment.

MATERIALS AND METHODS

Experimental conditions: The experiments were carried out at Department of Agricultural Engineering, Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia (Latitude: 11° 34.23' N; Longitude: 104° 52.20' E; Altitude; 280 m above sea level) during the growing seasons 2017/2018. Soil samples at the study area were taken to the laboratory of Royal University of Agriculture (RUA) to analyse pH = 7.21, Soil Organic Matter (SOM) = 0.84% was determined by the method of Walkley and Black (1934), Electrical conductivity (Ec) = 5,300 μS cm^{-1}, Nitrogen (N) = 0.021%, Phosphorus (P) = 32.90%, and Potassium (K) = 0.47%, Soil bulk density = 1.55 g cm^{-3}, Soil water content = 4.50%, and Soil texture (Sand = 77.14%, Silt = 14.29% and clay = 8.57%) = loamy sand was determined by a hydrometer (Bouyoucos, 1951).

Treatments and experimental design: The experiments were laid-out in randomized complete block design (RCBD) with three replications. Each experimental plot was raised 15 cm as a ditch above the ground with the size of 2 meters long and 1 meter wide occupying an area of $2m^2$. Melons were planted in two rows on the plot on 28 October 2017. The water budget system for irrigation is relatively straightforward, but must be adjusted for crop growth stage and environmental conditions such as rain. Applied water was calculated by estimating crop evapotranspiration (ETc), which was calculated using the FAO method (Doorenbos and Pruitt 1977) as ETc = ETo x Kc. The same amount of water was applied to all treatments (Table 1).

Table 1 Definitions of experimental treatments of irrigation water

Irrigation treatment	Description	Irrigation frequency	Amount of irrigated water (m^3/ha)
Treatment T_1	Drip irrigation	1 time/day	2,990
Treatment T_2	Drip irrigation	2 times/day	2,990
Treatment T_3	Drip irrigation	3 times/day	2,990
Treatment T_4	Hand-watering	2 times/day	2,990

Data collection: The cumulative trends of the vegetative growth parameters (plant height and plant diameter) for different treatments was recorded weekly when the plant reached 25 days old after

planting (Table 2(. Plant heights were determined by measuring the growing point of the main stem per 7 days, so a total of 9 times during the vegetative growth stage from 28 October to 04 November, 2017 were determined. Four plant samples were chosen from each plot in W-shape in order to measure some parameters such as plant height and plant diameter, blossom rate, fruit weight and fruit diameter, dried and wet mass of the plant.

Water use efficiency (WUE expressed in; kg m^{-3}) on yield basis was determined by dividing the yield (kg ha^{-1}) by the quantity of water applied (m^3 ha^{-1}) (sum of rainfall and quantity of water added by irrigation) during the growth period (Stanhill, 1987).

Statistical analysis and data interpretation: Collected data were subjected to the proper of statistical analysis of variance (ANOVA) of randomized complete block design (RCBD) as mentioned by Gomez and Gomez (1984). The combined ANOVA was carried out according to Steel et al. (1997), to estimate the main effects of the different sources of variation and their interactions. Differences were considered significant at $p < 0.05$. Treatment means were compared at 5% level of probability using the least significant difference (LSD) method (Steel et al., 1997), when the F-test for these treatments was significant at 5% probability level. Finally, all statistical analysis was carried out using SPSS computer software package while the graphic design was done with Microsoft Excel.

RESULTS AND DISCUSSION

Combined Analysis of Variance on Vegetative Growth

Table 2 Mean plant height and stem diameter for different treatments during vegetative growth period

Parameters	Days of planting	Treatment (Mean±S.E.)			
		T1	T2	T3	T4
Plant height (cm)	25 days	11.7 ± 1.1	12.1 ± 0.2	12.7 ± 1.2	12.5 ± 0.2
	32 days	22.7 ± 0.7	25.7 ± 0.5	28.2 ± 1.1	25.0 ± 0.6
	39 days	33.7 ± 0.3	35.3 ± 0.3	38.8 ± 0.3	30.4 ± 1.2
	46 days	52.7 ± 1.5	58.1 ± 0.5	63.3 ± 0.4	49.3 ± 1.8
	53 days	70.3 ± 1.6	73.3 ± 1.7	81.8 ± 3.0	63.0 ± 1.5
	60 days	95.0 ± 2.5	101.3 ± 4.0	111.7 ± 2.1	87.0 ± 5.1
	67 days	122.3 ± 1.5	137.3 ± 4.2	145.5 ± 6.1	110.7 ± 5.2
	74 days	148.3 ± 4.4	160.0 ± 0.0	176.9 ± 2.0	138.3 ± 4.4
	81 days	164.3 ± 3.5	170.3 ± 2.6	187.0 ± 2.0	148.3 ± 7.3
Plant diameter (mm)	25 days	3.9 ± 0.1	3.8 ± 0.1	3.9 ± 0.0	3.8 ± 0.1
	32 days	5.6 ± 0.1	5.3 ± 0.2	5.5 ± 0.1	5.1 ± 0.2
	39 days	6.8 ± 0.1	6.6 ± 0.1	6.9 ± 0.2	6.2 ± 0.1
	46 days	7.4 ± 0.2	7.1 ± 0.1	8.2 ± 0.2	6.8 ± 0.0
	53 days	8.3 ± 0.3	7.8 ± 0.2	8.8 ± 0.3	7.3 ± 0.2
	60 days	8.7 ± 0.2	8.2 ± 0.1	9.4 ± 0.3	7.8 ± 0.2
	67 days	9.8 ± 0.1	9.4 ± 0.2	10.7 ± 0.3	8.6 ± 0.1
	74 days	10.4 ± 0.1	10.2 ± 0.0	11.2 ± 0.2	9.3 ± 0.2
	81 days	10.6 ± 0.1	0.8 ± 0.1	11.5 ± 0.3	9.6 ± 0.1

Data were shown in mean ± S.E.

Irrigation regimes are one of the essential factors which can significantly affect the crop growth and yield. The plant height growth rate was defined as the ratio of the plant net growth amount for the adjacent measured values and the former plant height values, and the former plant height values is the reference (100%) value. It is an important index to research plants' dynamic growth (Zeng et