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Short communication

Effect of irrigation systems and frequencies on growth and yield of papaya

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ABSTRACT

A study was conducted to find out the effect of irrigation systems and frequencies on growth and yield of papaya cv. Pusa Delicious. Daily drip irrigation had given significant improvement in plant height, stem diameter and number of leaves per plant as compared to alternate day dripping, ring system of irrigation and control. However, the length of roots was more through alternate day dripping due to want of more water but the spread of feeding roots showed maximum with daily drip irrigation. Moreover, number of fruits per plant, fruit weight and fruit yield per plant were significantly highest with daily dripping.

Key words: Drip irrigation, papaya, growth, yield.

The papaya (*Carica papaya* L.) is an important fruit crop of tropical and sub-tropical regions of the world. It is native of tropical America. In India papaya occupies 80,000 ha of the total area under its cultivation with annual production of 26.86 lakh tonnes and 33 tonnes per hectare productivity (Kumar, 6). Papaya is a shallow rooted crop and is highly sensitive to fluctuation in soil moisture. The crop is extremely sensitive to collar rot under flood irrigated condition. It is cultivated either rainfed or with very less protective irrigation, which may lead to develop wilting, diseases and insects and this is the major reason for low productivity. The ring system of irrigation is generally followed traditionally however drip irrigation technology permits the efficient use of water and can help to maximize the utilization of land for papaya production (Padmakumari, 8). Drip irrigation can be thought of in rainfed areas with meagre water resources available during the periods other than the rainy seasons. However, the drip irrigation has to be dispensed 10-15 days before the expected harvesting period in order to improve the sweetness of the fruits. Looking the importance of drip irrigation system, the present study was taken up to evaluate the effect of irrigation systems and frequencies on growth and yield of papaya.

The experiment was carried out for consecutive two years at the Horticulture Research Farm, JNKVV, Jabalpur on newly planted papaya variety 'Pusa Delicious' during June at the spacing of 2 m × 2 m. A total of 12 treatments with four replications were subjected to Randomized Block Design (Fig. 1). Each treatment consisted of 5 plants for data recording and a total of 186 plants were hermaphrodite and remaining were the female plants out of 240 experimental papaya plants. Treatments T_1 to T_5, daily irrigation were applied through drip having crop factors of 0.4, 0.5, 0.6, 0.7 and 0.8, respectively. While T_6 to T_{10}, alternate day irrigation were applied through drip having crop factors of 0.4, 0.5, 0.6, 0.7 and 0.8, respectively. The calculation of crop factor was based on meteorological data however, scheduling of irrigation was dependent on the rainfall. Treatments T_{11}-ring system of irrigation (150-180 l/plant/week) and T_{12} as control (20-40 l/plant/week) were used for experimentation on papaya. The irrigation schedule was adopted throughout the year except rainy season. The irrigation source was a seasonal nalla. Water was first lifted from and stored in water storage tank and then used for irrigation purpose. The rainfall and evaporation pattern at experimental site was recorded as 1260 and 1690 mm/y, respectively. Water requirement was estimated by Pan Evaporation method for papaya (Doorenbos and Pruitt, 3). In the first and second year 4 lph per plant, in third year 8 lph emitter and in fourth year one 8 lph emitter along with one 4 lph emitter per plant were needed. The use of various emitters was based on wetting pattern in the soil which is directly correlated with the root depth and plant growth. Treatments T_{11} and T_{12} required 150-180 and 20-40 l of water per plant per week, respectively depending on the season. The installed drip system was evaluated for its uniformity of discharge of emitters. The emission uniformity was calculated 95.2%, hence the variation within emitters is acceptable. Data were recorded on various

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plant growth characters such as plant height, stem diameter, number of leaves per plant, length of tap root, spread of feeding root, number of fruits per plant, average fruit weight and average fruit yield per plant. The data were tabulated and statistically analyzed to discriminate the superiority of treatment means, using critical differences (Gomez and Gomez, 5).

A critical analysis of Table 1 revealed that plant height increased continuously and after 12 months of planting maximum height (135 cm) was recorded by the treatment T_4 followed by T_3 and T_2, whereas, the minimum (114.25 cm) was recorded in the treatment T_{11}. The mean monthly temperature at JNKVV campus, Jabalpur were recorded an d during winter (November to February) maximum temperature ranged between 21.0 and 26.6°C however the minimum temperature was ranged between 8.4 and 16.1°C. Frequent and regular irrigation proved that papaya plants did not get affected by low temperature. It was also clear from the table that daily dripping treatments recorded the higher plant height than the alternate day dripping treatments. Variation of plant height was observed with respect to water depths, to thermal units (degree days) and also to the interaction between these two. As far as the stem diameter of papaya plants is concerned it was observed that at the initial growth stage the alternate day dripping recorded greater stem diameter than daily dripping. However, after the 6th month of planting, the stem diameter increased more in case of daily dripping than the alternate day dripping. Furthermore, it was observed that after 12th month of planting highest stem diameter (29.7 cm) was recorded under T_3 followed by T_2. Thus, daily dripping significantly improved the stem diameter and confirming the importance of determining stem diameter as a function of degree days, which is supposed to be independent of location and planting season, but dependent of temperature accumulation. In harmony with this study, Srinivas (10), Awada *et al.* (2) and Sadarunnisa *et al.* (9) observed the similar results in papaya.

The data on number of leaves per plant were recorded highest by the treatment T_5 (22) and by T_4 (21.83). The lowest number of leaves per plant was recorded in the treatment T_{11} (18) which clearly indicated the effect of treatments on papaya plants. This could probably be related to the fact that in studies conducted by Aiyelaagbe *et al.* (1) and Awada *et al.* (2), while studying water stress in papaya trees, found that the number of leaves of plants subjected to water stress decreases only due to leaf abscission and not because of the number of emitted leaves, since the numbers of nodes in the plants were the same, and only the distance between nodes was different, under the different moisture regimes.

It was observed that the various treatments significantly affected the root growth of papaya plant. The maximum length (58 cm) of tap root was recorded with T_6 followed by T_9 and T_7. The data revealed that the tap root developed to more depth in the treatments with alternate dripping than those under daily dripping. The higher root depth was observed because root moved downwards in search of water. The spread of feeding roots on the contrary showed a opposite trend to that in case of length of tap root. Maximum spread (60.5 cm) of the spreading roots was recorded under T_4 however, T_{12} (control) showed the minimum spread (42.5 cm). This study was in agreement with the works of Marler and Discekici (7).

A perusal of Table 1 revealed that the daily dripping treatments significantly improved the number of fruits per plant, average weight of papaya fruits and fruit yield per plant. The highest fruit yield (63.96 kg) per plant was recorded with treatment T_4 followed by T_3 and T_2. This is due to more number of fruits per plant and higher average fruit weight. The minimum number of fruits (29.66) per plant and average fruit weight (1.30 kg) per plant were recorded with the treatment T_{12} under controlled conditions. Fruit weight is closely associated with a lack of soil water in the root zone; when the soil water deficit in the root zone increases, there is a loss in turgidity and a reduction in growth and fruit weight. In agreement with the present findings, Awada *et al.* (2), Srinivas (10 & 11), Goenaga *et al.* (4) also reported increased number of fruits, fruit weight and yield of papaya under drip irrigation system. Thus, the present study showed the daily drip irrigation significantly improved the growth characters, *viz.*, plant height, stem diameter, number of leaves per plant, length of tap root and spread of feeding roots alongwith yield and yield related characters compared to alternate day irrigation and ring basin system of irrigation.

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Table 1. Effect of irrigation systems and frequencies on growth and yield characteristics of papaya.

Growth characters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	Mean	CD at 5%
Plant height (cm)														
2 months	31.25	30.75	34.50	37.25	28.50	30.00	31.50	29.50	31.75	31.50	28.00	28.75	31.10	6.06
4 months	42.00	42.75	46.00	52.00	40.50	43.25	43.75	42.50	45.75	41.75	40.50	40.50	43.43	6.24
6 months	55.75	55.75	58.50	65.50	54.50	55.25	58.50	56.00	58.75	52.25	54.00	50.50	56.27	6.41
8 months	71.75	67.50	74.00	79.50	71.75	73.50	74.50	72.25	72.50	70.50	68.00	67.00	71.89	6.65
10 months	89.75	88.75	91.25	94.50	89.75	88.75	89.50	88.75	88.00	91.00	87.25	84.25	89.29	7.09
12 months	116.25	126.25	126.25	135.00	121.25	123.75	123.00	123.25	121.50	119.25	114.25	115.25	122.10	11.64
Stem diameter (cm)														
2 months	5.9	6.3	6.6	6.8	6.4	6.6	6.8	7.1	6.7	6.5	6.1	5.7	6.4	0.77
4 months	11.0	10.6	11.3	11.5	15.0	12.3	11.7	10.3	11.5	11.5	10.9	10.2	11.1	2.21
6 months	14.2	14.4	14.8	14.1	14.3	15.5	13.8	13.9	14.6	15.6	15.3	14.2	14.5	1.92
8 months	18.5	19.6	20.3	19.8	19.7	20.5	18.5	18.5	19.1	20.1	19.6	19.1	19.4	2.19
10 months	24.2	23.2	24.5	23.6	25.2	23.0	24.2	22.8	24.5	24.6	23.7	23.8	23.9	2.04
12 months	28.6	29.5	29.7	28.2	27.8	28.9	29.2	27.5	28.7	28.5	27.5	27.2	28.4	2.72
Number of leaves per plant														
2 months	14.66	13.00	15.50	14.33	13.00	14.00	12.33	13.00	14.66	13.00	13.00	13.66	13.67	6.56
6 months	19.00	17.66	18.66	18.33	18.00	20.00	16.66	19.00	16.66	17.66	17.00	17.00	17.96	7.34
12 months	21.00	19.66	20.00	21.33	22.00	19.66	19.00	19.00	19.66	21.00	18.00	19.00	19.94	7.98
Length of tap root (cm)														
	45.75	51.50	51.50	48.00	47.00	58.00	55.00	53.50	55.0	50.00	45.00	48.00	50.68	10.52
Spread of feeding root (cm)														
	48.00	53.50	56.00	60.50	52.75	49.00	47.00	45.00	45.50	48.00	50.00	42.50	49.81	10.20
Yield characters														
No. of fruits/plant														
	35.00	37.00	40.50	41.00	36.00	32.00	34.40	35.10	31.00	30.00	32.00	29.66	34.47	2.65
Av. weight/fruit (kg)														
	1.40	1.52	1.48	1.56	1.41	1.34	1.38	1.45	1.35	1.30	1.32	1.30	1.40	0.12
Av. fruit yield/plant (kg)														
	49.00	56.24	59.94	63.96	50.76	42.88	47.47	50.89	41.85	39.00	42.24	38.55	48.56	10.61

T_1 = drip irrigation daily (crop factor – 0.4), T_2 = drip irrigation daily (crop factor – 0.5), T_3 = drip irrigation daily (crop factor – 0.6), T_4 = drip irrigation daily (crop factor – 0.7), T_5 = drip irrigation daily (crop factor – 0.8), T_6 = drip irrigation alternate day (crop factor – 0.4), T_7 = drip irrigation alternate day (crop factor – 0.5), T_8 = drip irrigation alternate day (crop factor – 0.5), T_9 = drip irrigation alternate day (crop factor – 0.7), T_{10} = drip irrigation alternate day (crop factor – 0.8), T_{11} = ring system irrigation, T_{12} = control.

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