The Pharma Innovation Journal 2022; 11(1): 781-786

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(1): 781-786

www.thepharmajournal.com
Received: 09-11-2021
Accepted: 20-12-2021

Shashikant
Department of Soil and Water Engineering, SV College of Agricultural Engineering and Technology & Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya. Raipur Chhattisgarh, India

BL Sinha
College of Agriculture and Research Station, IGKV Bhatapara, Chhattisgarh, India

J Sinha
Department of Soil and Water Engineering, SV College of Agricultural Engineering and Technology & Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya. Raipur Chhattisgarh, India

MP Tripathi
Department of Soil and Water Engineering, SV College of Agricultural Engineering and Technology & Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya. Raipur Chhattisgarh, India

PK Verma
Department of Soil and Water Engineering, SV College of Agricultural Engineering and Technology & Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya. Raipur Chhattisgarh, India

KK Pandey
College of Agriculture and Research Station, IGKV, Bhatapara Chhattisgarh, India

Corresponding Author:
Shashikant
Department of Soil and Water Engineering, SV College of Agricultural Engineering and Technology & Research Station, Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya. Raipur Chhattisgarh, India

Effect of different levels of irrigation and fertigation on growth and yield of papaya

Shashikant, BL Sinha, J Sinha, MP Tripathi, PK Verma and KK Pandey

Abstract
The performance of drip irrigation in the field under various operating situations is key factor to ensure the required rate of water to all crops during growing periods. A unic characteristics of drip irrigation is the constant application of water and it is regulated by a robust design, management and adoption of the system. Preferably, a well-designed system discharges uniform water to each plant for meeting its needs of water in addition to feasible design and economics. Hence, a field experiment was conducted to study the effect of different levels of irrigation andfertigation on growth and yield of papaya during the year 2020-21 at Borsi Instructional Farm of Dau Kalyan Singh College of Agriculture and Research Station, IGKV, Bhatapara (C.G.). The experiment was laid out in the randomized block design with nine treatments combinations and three replications. The experiment comprised of nine treatments under drip method of irrigation with combination of three irrigation regimes *viz*. 60%, 80% and 100% of cumulative pan evaporation (CPE), three different levels of fertilizer 80%, 100% and 120% of RDF. The results showed that the maximum plant height (137.5 cm), number of leaves (33), early days to first flowering (76 days), earlier days to 50 percent flowering (92 days), earlier days to first fruiting (109 days), earlier days to 50% fruiting (127 days), highest number of fruits per plant (26), fruit length (42 cm), fruit diameter (9.45 cm), fruit weight (2.20 kg), fruit yield per plant (57.20 kg), fruit yield per unit area (143 t ha^{-1}) was observed highest in treatment irrigation of 100 percent of CPE and fertigation of 120 percent of RDF (T_9).

Keywords: Drip irrigation levels, fertigation levels, papaya growth and yield attributes

1. Introduction
Papaya (*Carica papaya* L.) has long been known as a Miracle fruit, of the tropics and grown primarily for its luscious and for separation of its ingestion constituent papain. It provides one of the maximum productions of fruits per hectare and a remunerative crop next to banana. The existing area under papaya farming is about 70 thousand hectare and production is around 1.5 million In Chhattisgarh the area under papaya cultivation is about 14.12 ha and production is around 352.84 tons and productivity is 24.99 tons per hectare (Ministry of Agriculture, 2016-17).

Rational use of irrigation water for agriculture is important for rising productivity and to save irrigation water, which is valuable and scanty resource. This can be gained by modern techniques of irrigation like trickle irrigation accompanied with other enhanced water management techniques. Drip irrigation is based on the basic approaches of irrigating root zone of crop rather than entire land surface, which results in maximum water use efficiency and crop yield. It also allows the application of fertilizer, pesticides and other water soluble chemicals applied with irrigation water with healthier crop response. Fertigation is a practice for uniformly distributing fertilizers to the crop along with water by drip irrigation on a regularly basis in precised way so as to permits for constant flow of nutrients by plants and to influence inputs of both water and fertilizer (Pandey *et al*., 2013) [7].

Drip irrigation evaluation in the field under a set of operating conditions is very important to ensure the desired discharge to all the growing crops. A best and desirable feature of trickle irrigation is the uniform distribution of water and it is governed by proper design, management and adoption of the system. Ideally, a well-designed system applies nearly equal amount of water to each plant to meets its water requirements in addition to rational design and economics. Fertigation decision involves kind of fertilizer (solid/liquid), dose of fertilizer, selection of the most effective formulations, proper preparing solutions for injection and scheduling injections to ensure that essential nutrients are made available to the plant as needed (Sebastian and Bindu, 2020).

In view of the above facts, an experiment is planned to carry a study on Effect of Irrigation and Fertigation Levels on Performance of Papaya Crop (*Carica papaya* L.) under Drip Irrigation. Hence, the present study will be undertaken with the following specific objectives:

Materials and Methods

A field experiment was conducted at Borsi research farm, Dau Kalyan Singh agriculture college and research station, Bhatpara (IGKV, Raipur) Chhattisgarh during the July 2020 to may 2021. The experimental site is situated in the central part of Chhattisgarh in India. In this location the mean minimum temperature 10 ºC and mean maximum temperature is 43 ºC. The average relative humidity is 60.43 percent and average wind velocity is 2.10 ms^{-1}. Te experiment site has sandy loam soil and falls under the semiarid zone. The experiment field was 88.8 m long and 46.2 m wide. The row to row spacing 1.65 m and plant to plant spacing 2.4 m. Recommended cultural operation are followed in raising the crops. The mean value obtained was used for estimating analysis of critical difference. These investigations were carried out using nine treatments with three replications. Treatments were tested in randomized block design. The details of treatments are given below.

Irrigation treatments for papaya crop

I_1 - Drip irrigation with IW/CPE (Irrigation water/ cumulative pan evaporation ratio of 0.6
I_2 - Drip irrigation with IW/CPE (Irrigation water/ cumulative pan evaporation ratio of 0.8
I_3 - Drip irrigation with IW/CPE (Irrigation water/ cumulative pan evaporation ratio of 1.0

Fertigation treatments for Papaya crop

F_1 - 80% of Recommended Dose of Fertilizer
F_2 - 100% of Recommended Dose of Fertilizer
F_3 - 120% of Recommended Dose of Fertilizer

Estimation of irrigation water requirement (V)

Reference crop evapotranspiration (ET0) was calculated using Modified Penman Method (Doorenbos and Pruitt, 1977) [3]. The crop co-efficient (Kc) for different growth stages of papaya was selected. The actual crop evapotranspiration was estimated by multiplying reference crop evapotranspiration, crop co-efficient, area under each plant and wetting fraction. The crop water requirement of papaya crop was estimated by using the following equation:

$$V = ETo \times Kc \times Ap - Ap \times Re \quad \ldots (1)$$

Where,
V = Net depth of irrigation (litre/day/plant)
ETo = Reference crop evapotranspiration (mm/day)
Kc = Crop co-efficient
Ap = A x W = Effective area to be irrigated (Sq.m)
A = Area allocated to each plant (Sq.m)
W = Wetting fraction
Re = Effective rainfall (mm/day).

The water requirement was estimated for the growing season of papaya. Daily time of operation of drip irrigation system was worked out. Drip irrigation was scheduled on Daily; hence total quantity of water delivered was cumulative water requirement of two days minus effective rainfall (if rain occurred).

Result and Discussion

Growth Parameters of Papaya

Data of the Table 1 clearly revealed that the growth attributing characters of papaya like plant height (137.5 cm) was recorded highest in treatment T_9 (100 percent irrigation and 120 percent fertigation level), followed by T_8, T_7 and T_6 having plant heights of 133.4, 128 and 127 cm, respectively (shown in Fig. 1). Minimum plant height (122 cm) was observed in treatment T_1 (60 percent irrigation and 80 percent fertigation level). Number of leaves) (33) was found maximum under the treatment T_9, followed by T_8, T_7 and T_6 having number of leaves 30, 28.33 and 27, respectively (Fig. 2). Minimum number of leaves (20) was observed in treatment T_1. Days to first flowering (82 days) were maximum recorded under the treatment T_1, followed by T_2, T_3 and T_4 having first flowering of 81.33, 80.67 and 80 days respectively (Fig. 3). Earlier first flowering was observed in treatment T_9 (76 days). The maximum days to fifty percent flowering (Fig.4) (101.67 days) was noted under the combine effect of 60 percent irrigation levels and 80 percent fertigation levels (T_1), followed by T_2 having fifty percent flowering of 100.33 days, respectively. The earlier days to fifty percent flowering were observed in treatment T_9 (92 days). The delayed first fruiting (Fig. 5) (121.67 days) was recorded under the treatment T_1, followed by T_2 having first fruiting of 120.33 days, respectively. Minimum days to first fruiting were observed in treatment T_9 (109 days). The maximum days to fifty percent fruiting (Fig. 6) (143.67 days) was recorded under the treatment T_1, followed by T_8 having fifty percent fruiting of 142.33 Days, respectively. Earlier days to fifty percent fruiting were observed in treatment T_9 (127 days). Similar findings have been observed by researchers Srivastava *et al*, (2014) [10], Hazarika *et al*, (2016) [4], Mirza *et al*. (2018) [6], Shethy *et al*. (2019) [9] and Devarakonda *et al*, (2020) [2].

Table 1: Growth attributing as influenced by different irrigation and fertigation levels of papaya

Treatments	Plant height (cm)	Number of leafs	Days to first flowering	Days to 50% flowering	Days to first fruiting	Days to 50% fruiting
T_1	122.0	20.00	82.00	101.67	121.67	143.67
T_2	124.5	23.40	81.33	100.33	120.33	142.33
T_3	125.8	24.00	80.67	99.00	119.00	141.00
T_4	125.0	24.00	80.00	98.00	116.00	137.00
T_5	126.2	26.30	79.33	97.33	115.33	136.33
T_6	127.0	27.00	78.33	96.33	114.33	135.33
T_7	128.0	28.33	78.33	95.00	112.00	130.00
T_8	133.4	30.00	77.67	93.67	110.67	128.67
T_9	137.5	33.00	76.00	92.00	109.00	127.00
SE(M)±	1.84	0.51	0.79	0.76	0.79	0.80
CD at 5%	5.25	1.45	2.25	2.18	2.25	2.30

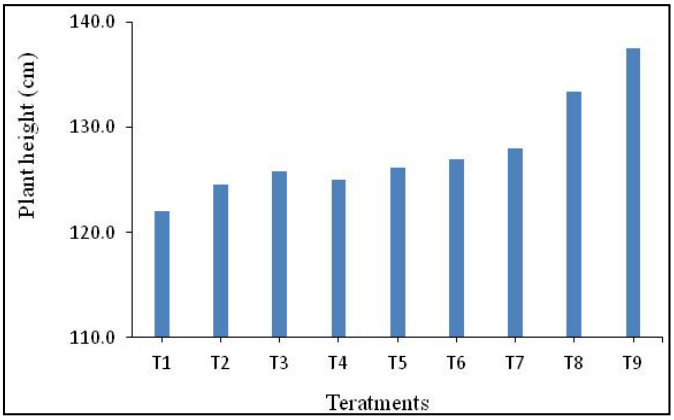

Fig 1: Effect of various treatments on Height Plant

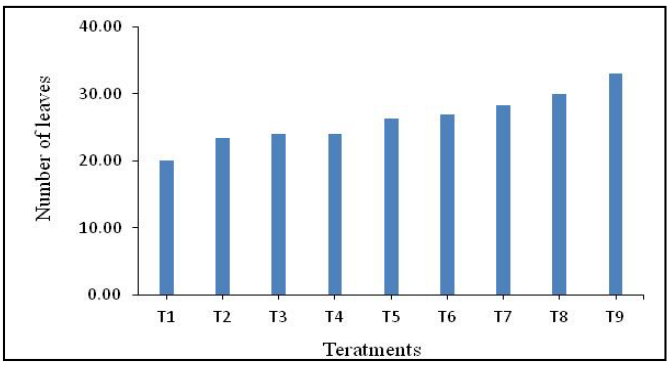

Fig 2: Effect of various treatments on Number of Leaf

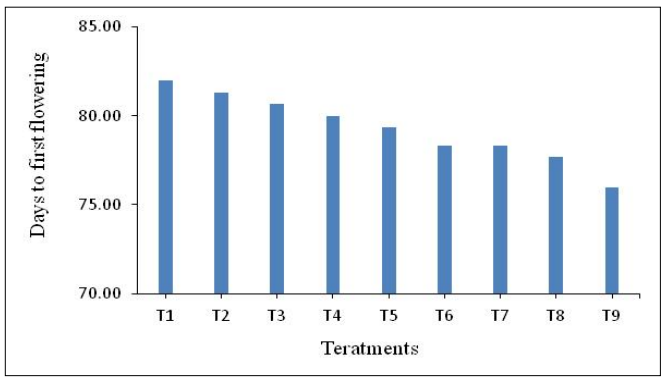

Fig 3: Effect of various treatments on Days to 1st Flowering

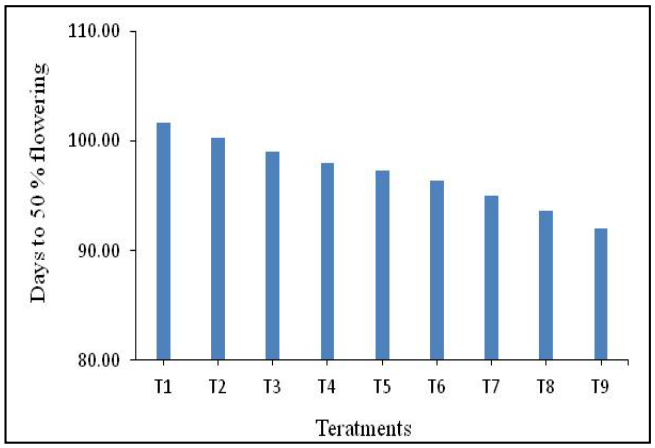

Fig 4: Effect of various treatments on Days to 50% Flowering

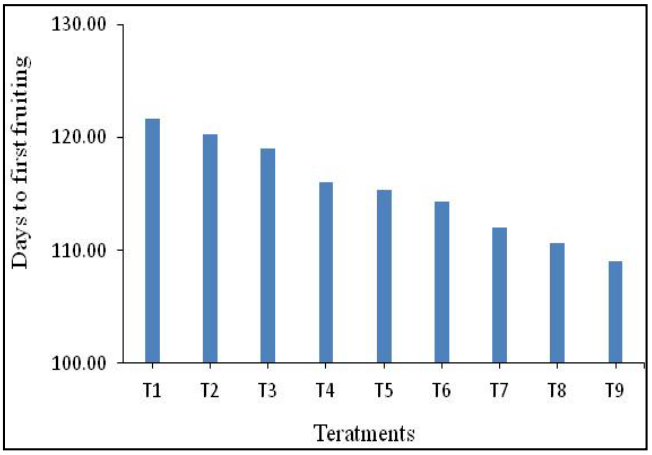

Fig 5: Effect of various treatments on Days to 1st Fruiting

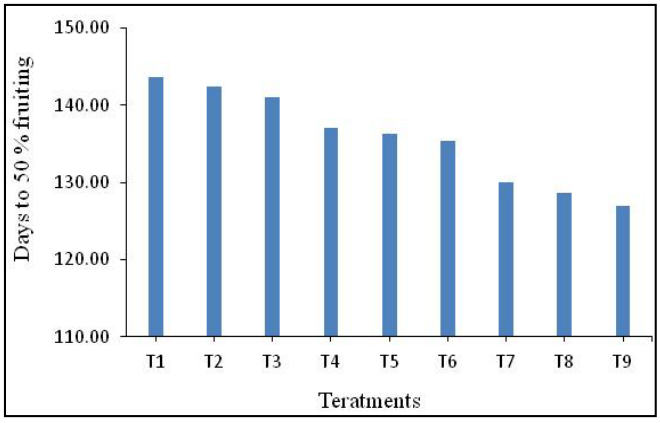

Fig 6: Effect of various treatments on Days to 50% Fruiting

Yield attributing

The results revealed that yield attributes (Table 2) under different levels of irrigation and fertigation of papaya planting. The highest number of fruits per plant (Fig. 7) (26) was counted under the T_9, followed by T_8, T_7, T_6, T_5, T_4 and T_3 having number of fruits per plant of 24, 23.60, 23, 22.67, 22 and 21.20, respectively, and minimum amount of fruits per plant was recorded in treatment T_1 (18). Similar findings have been observed by Hazarika *et al*, 2016 [4]. The largest fruit length (Fig. 8) (42 cm) was recorded under the treatment T_9, while the minimum (28 cm) was observed in treatment T_1. Diameter of petiole (Fig. 9) (9.45 cm) was highest with treatment T_9 and followed by treatments T_8, T_7, T_6, T_5, T_4 and T_3, having fruit diameter of 9.20, 8.77, 8.46, 8.22, 7.93 and 7.32 cm, respectively. Minimum fruit diameter was observed in treatment T_1 (6.15 cm). It is clear from the table that average fruit weight (Fig. 10) was recorded significantly the highest (2.20 kg) in treatment T_9 followed by T_8, T_7 and T_6, having fruit weight of 2.00, 1.95 and 1.85 kg, respectively. It was observed that are minimum fruit weight was observed in treatment T_1 (1.30 kg). The daily application of water through drip equal to 100% CPE and 120% RDF (T_9) gave maximum yield per plant (Fig. 11) (57.20 kg) and followed by T_8 and T_7 having fruit yield of 48.00 and 46.02 kg, respectively. The observations indicate that there was minimum fruit yield was observed in treatment T_1 (25.35 kg). Greater yield per plant obtained in treatments might be due to application of optimal level of irrigation through drip and fertigation (120 percent

RDF) (Sebastion 2020) [8]. The different combination of irrigation and fertigation levels, highest yield (Fig. 12) (143 t ha^{-1}) were obtained in 100 per cent irrigation of CPE level and fertigation level (120% of RDF), whereas, minimum yield (63.38 t ha^{-1}) in 60 per cent irrigation of CPE level and fertigation level (80% of RDF). Similar findings have been reported by researchers Shethy *et al.* (2019) [9] and Devarakonda *et al*, (2020) [2]. Judicious application of water directly to the root zone through drip irrigation could improve plant growth and development by maintaining optimum soil moisture and eliminating water stress to the plant (Deshmukh *et al.* 2014) [1].

Table 2: Yield attributing as influenced by different irrigation and fertigation levels of papaya

Treatments	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	Fruit yield (kg plant^{-1})	Fruit yield (t ha^{-1})
T_1	19.5	28.00	6.15	1.30	25.35	63.38
T_2	20.4	29.80	6.69	1.40	28.56	71.40
T_3	21.2	31.00	7.32	1.50	31.80	79.50
T_4	22.00	32.40	7.93	1.65	36.30	90.75
T_5	22.67	34.90	8.22	1.75	39.67	99.18
T_6	23.00	36.00	8.46	1.85	42.55	106.38
T_7	23.60	38.00	8.77	1.95	46.02	115.05
T_8	24.00	40.00	9.20	2.00	48.00	120.00
T_9	26.00	42.00	9.45	2.20	57.20	143.00
SE(M)±	0.73	0.61	0.30	0.10	3.43	8.57
CD at 5%	2.09	1.74	0.87	0.28	9.80	24.50

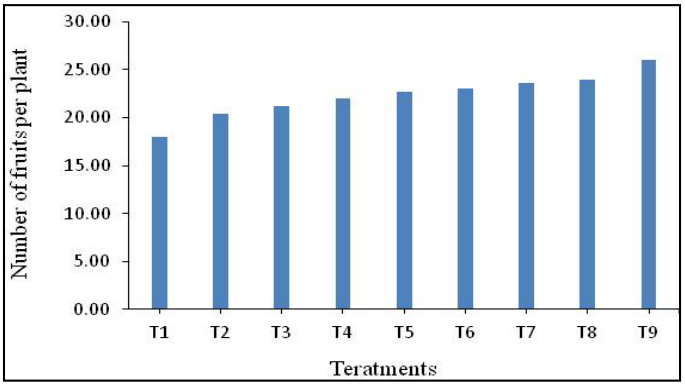

Fig 7: Effect of various treatments on Number of Fruits per Plant

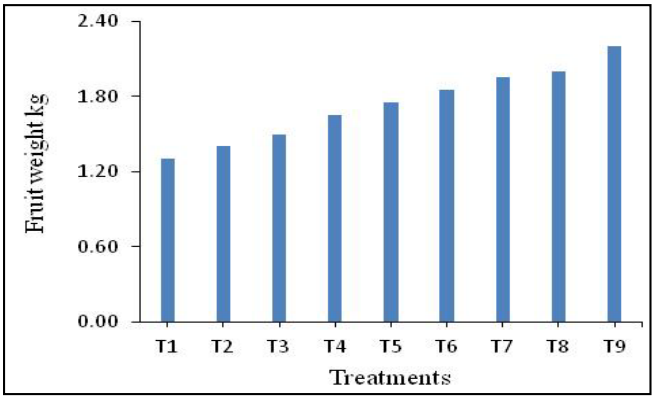

Fig 10: Effect of various treatments on Weight of per Fruit

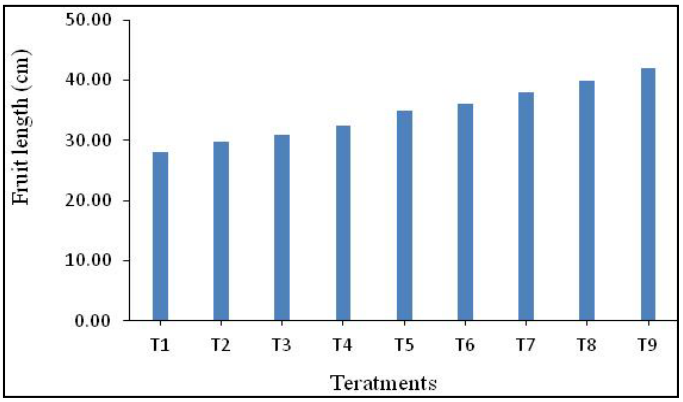

Fig 8: Effect of various treatments on Fruit Length

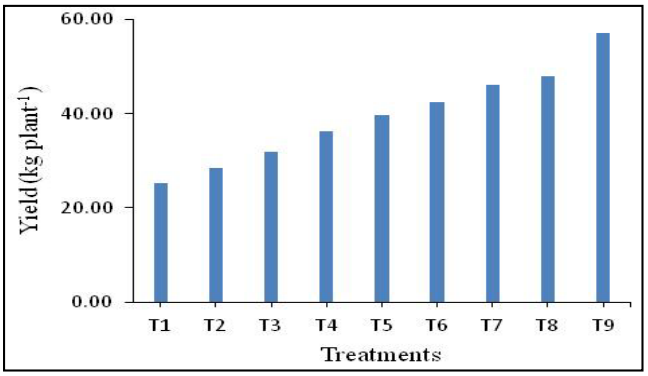

Fig 11: Effect of various treatments on Yield per Plant

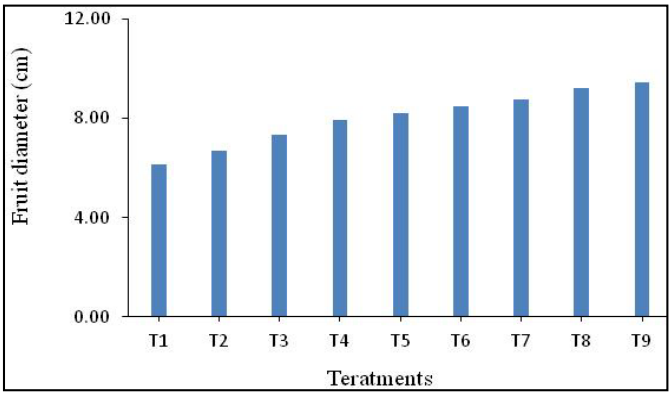

Fig 9: Effect of various treatments on Fruit Diameter

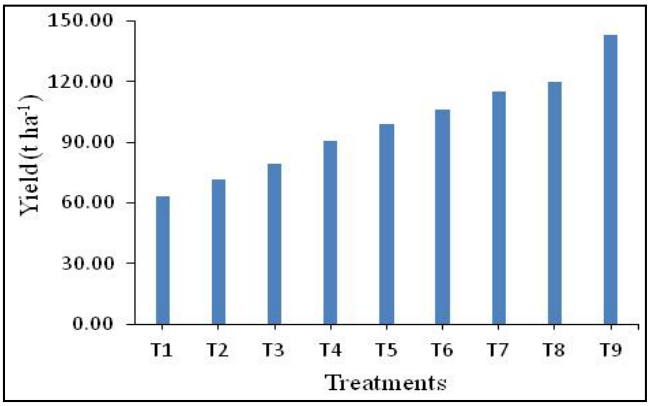

Fig 12: Effect of various treatments on Yield

Water and Fertilizer Use Efficiency

The water usage efficiency is important parameters in identifying constraints on improving the efficient use of water, as well as being a tool for increasing crop production and economizing water, in addition to preserving the environment. Details of the water use efficiency for all the treatment are presented in Table 3 and figure 13 and 14. It was also recorded that the highest water use efficiency 96.89 kg ha^{-1} mm^{-1} was found in treatment T_3 which was statistically at par with T_9 and the minimum water use efficiency 72.41 kg ha^{-1} mm^{-1} was observed in treatment T_1 due to very low yield response to the amount of water applied. Thus water use efficiency should be considered an important attribute in helping farmers increase their income through productivity and water saving, especially in areas deprived of water (Liu *et al*, 2013) [5].

The data from table reveals that the fertilizer use efficiency was found higher in treatment T_7 (0.51) which was statistically at par with T_9 and lowest in treatment T_3 (0.25). The higher fertilize; use efficiency for the treatment T_7 was mainly attributed to lower dose fertilizer application. The minimum fertilizer use efficiency was observed in treatment T_3 due to very low yields response to the amount of fertilizer applied.

Table 3: Water and fertilizer use efficiency under different treatment

Treatment	Water use efficiency (kg ha^{-1} mm^{-1})	Fertilizer use efficiency (q kg^{-1})
T_1	72.41	0.28
T_2	87.40	0.27
T_3	96.89	0.25
T_4	80.77	0.43
T_5	85.60	0.36
T_6	89.26	0.32
T_7	76.74	0.51
T_8	80.05	0.43
T_9	95.39	0.47
SE(M)±	1.78	0.017
CD at 5%	5.02	0.05

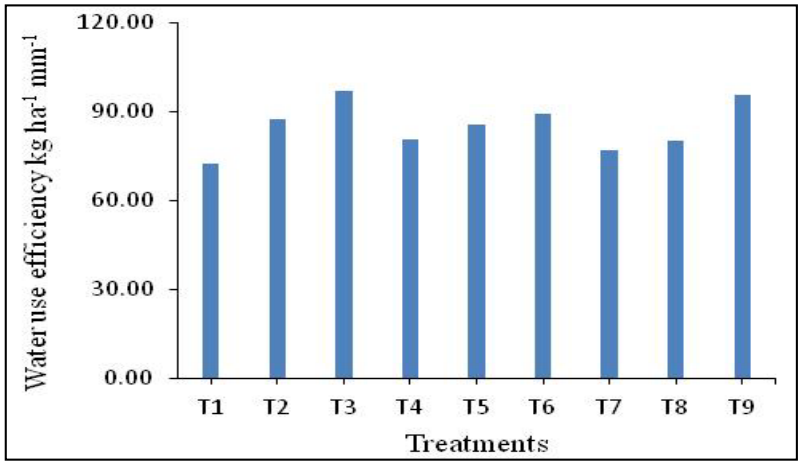

Fig 13: Effect of water use efficiency on various treatments

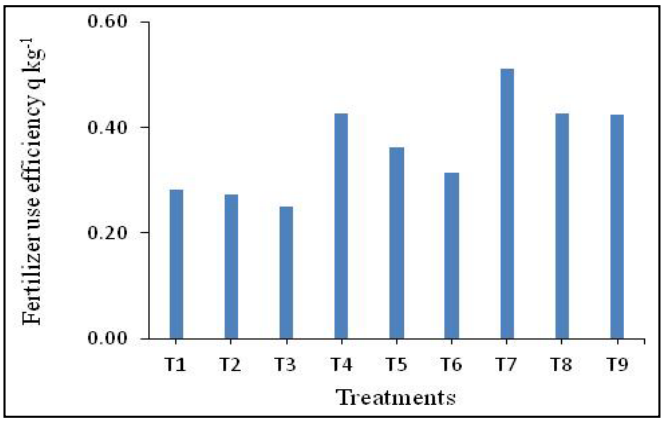

Fig 14: Effect of fertilizer use efficiency on various treatment

Conclusions

Based upon the results on yield and yield attributes of papaya of present investigation concluded that the treatment irrigation of 100 percent of CPE and fertigation of 120 percent of RDF (T9) gave better growth, yield attributes and yield (143 t ha^{-1}) of papaya cultivar Red lady under study area. However, the water use efficiency and fertilizer use efficiency was found better in treatment T_3 and T_7.

References

1. Deshmukh G, Hardaha MK. Effect of irrigation and fertigation scheduling under drip irrigation in papaya. Journal of Agri Search. 2014;1(4):216-220.
2. Devarakonda S, Madhumathi C, Umamahesh V, Lakshmi LM, Reddy MLN, Bhaskar VV *et al*. Growth, flowering and yield Responce of papaya (*Carica papaya* L.) cv. red lady to exogenous application of salicylic acid and Jasmonic acid. The Pharma Innovation Journal. 2020;9(5):160-165. TPI 2020;9(5):160-165 © 2020. TPI www.thepharmajournal.com.
3. Doorenbos J, Pruitt WO. Giudelines for predicting crop water requirement. Irrig. and drain. Paper No. 24, FAO, Rome, Italy. 1977.
4. Hazarika TK, Sangma BD, Mandal D, Nautiyal BP, Shukla AC. Effect of plant growth regulators on growth, yield and quality of tissue cultured papaya *(Carica papaya*) cv. Red Lady. Indian Journal of Agricultural Sciences. 2016;86(3):404-8. March 2016. https://www.researchgate.net/publication/301654923.
5. Liu X, Shao L, Sun H, Chen S, Zhang X. Responses of yield and water use efficiency to irrigation amount decided by pan evaporation for winter wheat. Agric. Water Manage. 2013;129:173-180.

6. Mirza A, Jakhar R, Singh J. Response of organic practices, mulching and plant growth regulators on growth, yield and quality of papaya (*Carica papaya* L) cv. Taiwan Red Lady. Indian J Agric. Res. 2018, 2019;53(1):96-99. DOI: 10.18805/IJARe.A-5127.
7. Pandey AK, Singh AK, Kumar A, Singh SK. Effect of drip irrigation, spacing and nitrogen fertigation on productivity of chilli (*Capsicum annuum* L). Envi. & Ecol. 2013;31(1):139-142.
8. Sebastian K, Bindu B. Effect of fertigation and foliar nutrition on growth and yield of papaya cv. Surya. International Journal of Chemical Studies 2020;8(5):1078-1083. DOI: https://doi.org/10.22271/chemi.2020.v8.i5o.10440.
9. Sethy BK, Dash DK, Tarai RK, Dash SN, Dash AK. Effect of Integrated Nutrient Management on Vegetative Growth, Flowering and Yield of Papaya (*Carica papaya* L.) cv. Coorg Honey Dew. International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 Int. J. Curr. Microbiol. App. Sci 2019;8(10):2400-2407. https://doi.org/10.20546/ijcmas.2019.810.278.
10. Srivastava A, Singh JK, Singh HK. Integrated nutrient management (INM) on growth, yield and quality of papaya (*Carica papaya* L.) cv. CO-7. The Asian Journal of Horticulture. 2014;9(2):390-395.