Enhancing growth and yield parameters in mulberry through different levels of drip irrigation and mulching

Abstract: The experiment was conducted to find out the impact of levels of drip irrigation and mulching on growth, yield and quality parameters of mulberry. Among levels of irrigation 0.8 CPE recorded higher values for growth and yield (47613 kg ha^{-1} $year^{-1}$) parameters. Compared to lower levels of irrigation 0.5, 0.6 and 0.7 CPE. Also, mulberry plants mulched with black plastic polythene cover recorded higher values for growth and yield (45143 kg ha^{-1} $year^{-1}$) compared to plants without mulching. The study revealed that adoption of drip irrigation in mulberry at 0.8 CPE along with mulching is appropriate to enhance the growth parameters (plant height, number of shoots, number of leaves, leaf area and total dry matter content) and leaf yield.

Keyword: CPE – Cumulative pan evaporation, leaf yield and quality parameters

INTRODUCTION

Mulberry is a hardy and perennial plant shows short proliferation period, fast growth rate and plant adapts itself to varied environmental conditions like tropical, subtropical and temperate regions. Mulberry leaf is the major economic component in sericulture where production of quality leaf per unit area has a direct effect on cocoon quality. Cautious use of water to be followed for obtaining higher leaf quality and quantity. Higher moisture content of mulberry leaf is one of the important criteria which has a direct effect on growth and development of silkworms. Moisture content in mulberry leaves improves ingestion and digestion also helps in conversion of nutrients in silkworm body. Moisture content in mulberry leaves is considered as one of the most important criteria in assessing the leaf quality (Paul *et al.*, 1992). Factors responsible for successful cocoon crop are *viz.*, silkworm race (4.2 %), silkworm egg (3.1 %), rearing techniques (9.2 %), local weather condition (37.1 %), mulberry leaves (38.1 %) and other factors (6.6 %). By this it is clearly evident that the mulberry leaf plays a foremost role in cocoon production as it is only single source of nutrition to the silkworm and the improvement of leaf quality and the productivity of leaves is immediately required for the stability of cocoon crops (Miyashita, 1986). Mulberry leaf is the major economic component in sericulture where production of quality leaf per unit area has a direct effect on cocoon quality. Judicious use of water to be followed for obtaining higher leaf quality and quantity. Higher moisture content of mulberry leaf is one of the important criteria which has a direct effect on growth and development of silkworms.

MATERIAL AND METHODS

The experiment was conducted during winter 2019 at the Department of Sericulture, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bangalore. The field is located at a latitude of 12°58′ N, the longitude of 77°35′ east and at an altitude of 930 m above mean sea level in the Eastern Dry Zone (Zone-5) of Karnataka. V-1 mulberry variety was chosen for experiment and garden was middle pruned and ploughed followed by clod crushing and harrowing. FYM was applied at the rate of 20 t ha^{-1} $year^{-1}$ and incorporated into the soil homogenously by hoeing. The gardens were maintained with recommended package of practices (Dandin *et al.* 2003) uniformly during the experimentation. The experiment was laid out in strip plot design consisting of eight treatment combinations and replicated five times.

Treatment details:

The experiment was laid out in strip plot design consisting of two factors in the experiment *viz.,* Factor A – levels of irrigation (L_1-0.5 CPE, L_2-0.6 CPE, L_3-0.7 CPE and L_4-0.8 CPE) and Factor B – levels of mulching (M_1-with mulching and M_0-without mulching). Combination of both factors comprises eight treatment combinations and replicated five times.

Mulching

Mulching to the plot was done by covering the soil surface uniformly on both side of mulberry plants paired rows with a 70-micron thick UV stabilized black polythene mulch film.

Drip irrigation

The chosen drip irrigation method was laid out in mulberry garden with 16 mm in-line drip laterals which were connected to sub mains and laid on surface all along the paired rows and in-line drippers were placed on lateral tubes at a distance of 40 cm with rate of discharge of 2.5 lph. One end of the lateral tube was connected to sub mains and another end of the tubes were closed with end caps. Each lateral is fitted with a 16 mm tap for controlled irrigation as per the experimental plan. The lower end of the sub main was connected with the flush valve.

The blank irrigation was given to whole experimental plot two days before starting of experiment to bring the moisture level of soil to field capacity. Following irrigations were given three days once and different irrigation treatments were executed on the basis of Cumulative Pan Evaporation (CPE) through climatological approach (Jenson *et al.*, 1961). The total quantity of water applied to individual plots at each irrigation was measured through the fixed water meter. The calculated volume of water was supplied to different treatment plots during each irrigation.

Collection of experimental data

A sample comprising of five plants for each treatment was randomly selected and labelled for recording various observations. The observations on various growth parameters and quality parameters were recorded at 30, 45 and 60 DAP. The Leaf yield and NPK was recorded at 60 DAP (at harvest). The methodology and procedure followed to record the observations are presented below.

Growth and yield parameters

Plant height (cm)

Plant height was measured from base of the plant to the fully opened top leaf in randomly selected five plants and expressed in centimetres.

Number of shoots plant^{-1}

Number of shoots were counted in randomly selected five plants and average number of shoots per plant was calculated and expressed as number of shoots plant^{-1}.

$$\text{The average number of shoots per plant} = \frac{\text{Total number of shoots}}{\text{Number of plants}}$$

Number of leaves plant^{-1}

The total number of leaves in each branch of the plant was counted from randomly selected five mulberry plants in five replications and average was computed and expressed as number of leaves plant^{-1}

$$\text{The average number of leaves per plant} = \frac{\text{Total number of leaves}}{\text{Number of plants}}$$

Leaf area (cm^2)

Five leaves were randomly selected from a plant and measured length and width wise using centimetre scale manually in randomly selected and labelled five plants and the product is multiplied by the correction factor 0.69 and their mean values are expressed as leaf area in cm^2.

Total dry matter accumulation plant^{-1} (g)

The dry matter accumulation plant^{-1} was studied at three growth stages. Three plants were erratically selected from the plot and leaves from the shoots were separated. Dry weight of biomass was recorded by subjected to air drying and later on oven dried at 60 ^{0}C to obtain constant weight. The average dry weight was calculated and expressed as g plant^{-1}.

Leaf yield

Leaf yield plant^{-1} was noted by harvesting the fresh leaves from randomly selected three plants at harvest (60 DAP) and average yield plant^{-1} was calculated. Leaf yield per hectare was calculated by harvesting the fresh leaves from net plot area from different treatments and fresh leaf yield was expressed as t ha^{-1}.

Statistical analysis: Data recorded on mulberry were analysed statistically by using Stat software WASP (strip plot). The treatment means and interaction effects were compared using critical difference values at 5 per cent. The significance level used in F and t-tests was P=0.05 for strip plot (Gomez and Gomez, 1984). The critical difference (CD) values were computed where the F-test was found significant.

RESULTS AND DISCUSSION

In the present study results revealed that mulberry responded differently to different levels of irrigation, mulching and their interaction effect in terms of growth, yield and quality parameters of mulberry leaf has been investigated, as research was done in strip plot where interaction effect results are calculated. The growth and yield parameters of mulberry are present in **table 1a.** Highest plant height (109.18 cm) was recorded in mulching and lowest (91.40 cm) was in without mulching. Among different levels of irrigation higher level of irrigation 0.8 CPE showed the maximum plant height (123.28 cm) whereas lowest (84.94 cm) was recorded in 0.5 CPE. Highest number of shoots plant^{-1} (23.23) was recorded in mulching and lowest (22.35) was recorded in without mulching. Among different levels of irrigation higher level of irrigation 0.8 CPE produced the maximum number of shoots plant^{-1} (24.78) than lower level of irrigation in 0.5 CPE (20.58) was recorded in 0.5 CPE. Highest number of shoots per plant at 80 per cent of surface drip irrigation level was obtained by Arunadevi *et al*. (2007) which was supported by the findings of Siddalingaswamy *et al.* (2007) who reported, among the methods of irrigation better performance was observed in drip irrigation on shoot yield with an increase of 25 per cent over traditional furrow method. Mulching recorded highest number of leaves plant^{-1} (315.15) than without mulching (307.19). Among different levels of irrigation higher level of irrigation 0.8 CPE showed the maximum number of leaves plant^{-1} (328.04) whereas lowest (296.96) was recorded in 0.5 CPE. Similar findings were recorded by Sudakhar *et al* (2018) that number of leaves (266.2) found highest in drip irrigation when compared to flood irrigation. In present study number of leaves were more compared to this study this increase in number of leaves might be due to higher level of irrigation and mulching Highest leaf area (161.56 cm^2) was recorded in mulching and lowest (128.05 cm^2) was recorded in without mulching. Higher level of irrigation 0.8 CPE showed the maximum leaf area (190.07 cm^2) and minimum (104.82 cm^2) was recorded in 0.5 CPE which was found on par with (131.19 cm^2) 0.6 CPE. The results are in conformity with the study of Sakthivel (2019) who reported mulberry leaf area (184.2 cm^2) found highest in drip irrigated plots compared to control (furrow Irrigated plots). Highest dry matter production (388.92 g plant^{-1}) was recorded in mulching and lowest (372.31 g plant^{-1}) was recorded in without mulching. Higher level of irrigation 0.8 CPE showed the maximum dry matter accumulation (408.12g plant^{-1}) and minimum was recorded (336.78 g plant^{-1}) in 0.5 CPE. At 60 DAP, leaf yield plant^{-1} (g) differed significantly due to different levels of mulching and levels of irrigation. Highest leaf yield (650.15 g plant^{-1}, 9028.67 kg ha^{-1} crop^{-1} and 45143.33 kg ha^{-1} year^{-1}) was recorded in mulching and lowest (602.86 g plant^{-1}, 8371.86 kg ha^{-1} crop^{-1} and 41859.81 kg ha^{-1} year^{-1}) was recorded in without mulching. Among different levels of irrigation higher level of irrigation 0.8 CPE showed the maximum leaf yield (685.73 g plant^{-1}, 9522.67 kg ha^{-1} crop^{-1} and 47613.35 kg ha^{-1} year^{-1}) whereas lowest (572.91 g plant^{-1}, 7955.96 kg ha^{-1} crop^{-1} and 39779.78 kg ha^{-1} year^{-1}) was recorded in 0.5 CPE.

In interaction **(table 1b)** 0.8 CPE along with mulching (T_8) recorded higher values for all the growth and yield parameters compared to other combination of treatments and lower values for the same were recorded in 0.5 CPE along in without mulching plot. The overall results revealed that yield increased with increased in quantity of water applied which was supported by findings of Ahluwalia *et al.* (1998) who reported that sugar cane yield increased with 1.0 CPE of irrigation compared to 0.4 CPE under surface drip irrigation. Benchamin *et al.* (1997) found that drip irrigation system was more efficient with 15 per cent increased leaf yield over furrow irrigation under any quantum of irrigation treatment. In confirmation to that Seenappa *et al.* (2016) results showed that higher leaf yield was obtained in higher level of irrigation (1.0 CPE) and mulching plots than lower level of irrigation and non-mulching plots these results were in accordance with present investigation which was also supported by findings of Sarathchandra (1999).

Discussion: Wider spacing (paired row) and irrigated conditions encourage growth of plenty of weeds in mulberry ecosystem. The weeds compete for space, sunlight, soil moisture and nutrients, thus affect the crop production. In the present investigation, the adverse effect of weeds was well pronounced in the non-mulching plots. However, black polythene mulching recorded reduction in weeds and improvement in soil moisture and these factors might have attributed to higher value in growth parameters of mulberry like plant height, leaf area, number of shoots and finally improvement in leaf yield over non mulching plots. The opaqueness of black polythene sheet is a greatest advantage to arrest the growth of weeds as it does not allow the sunlight to pass through it to the soil surface.

Further its water proof property prevents the moisture loss due to evaporation from the soil surface which is also reported under several studies (Ramakrishna *et al.*, 2006; Liu *et al.*, 2014 and Bakshi *et al.*, 2015). In surface drip 10 per cent (Evett *et al.*, 1995) of irrigated water which could be saved when plots are covered by mulching. in drip irrigation water is directly supplied to crop root zone which favours the better absorption and uptake of available nutrients from the soil which favours the better growth of foliage in mulberry which adds increase in leaf yield.

CONCLUSION: As irrigation is given based on evaporation rate there is a judicious use of water and water is irrigated based on climatic condition and requirement of crop. Drip irrigation is the most operative way to convey directly water and nutrients to plants thereby increases the growth and yield parameters especially in mulberry because here foliage is the economic part. In levels of irrigation 0.8 CPE found most effective with black plastic polythene mulch compared to conventional method of irrigation in utilizing the scarce resource like water and along with that plastic mulching helps to save the water in the root zone which helps the plant to maintain sufficient moisture level to uptake the available nutrients in the soil.

The mulberry growing farmers irrigate the crop field without the knowledge of crop water requirement which leads to unnecessary wastage of water during dry spell, by adopting levels of irrigation wastage of water can be minimized to certain level. Added to this Government of Karnataka is also supporting farmers by giving subsidy to adopt drip irrigation, this also reduces the investment cost.

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Table 1a: Effect of different levels of irrigation and mulching on growth, yield and quality of mulberry leaf at harvest (60 DAP)

Treatments	Plant height (cm)	No. of shoots plant^{-1}	No. of leaves plant^{-1}	Leaf area (cm^2)	Total dry matter (g plant^{-1})	Leaf yield (g plant^{-1})	Leaf yield (kg ha^{-1} yr^{-1})
M_1	109.18	23.23	315.15	161.56	388.93	650.15	45143
M_0	91.40	22.35	307.19	128.05	372.31	602.86	41859
F-test	*	*	*	*	*	*	-
S.Em. ±	1.29	0.196	0.83	5.44	5.448	6.77	-
CD @5%	3.58	0.546	2.32	21.38	21.388	18.79	-
L_1	84.94	20.58	296.96	104.82	336.78	572.91	39780
L_2	92.97	22.11	303.94	131.19	385.96	597.97	41520
L_3	99.97	23.70	315.74	153.12	391.62	649.41	45092
L_4	123.28	24.78	328.04	190.07	408.12	685.73	47613
F-test	*	*	*	*	*	*	-
S.Em. ±	3.74	0.415	1.302	6.08	7.746	18.26	-
CD @5%	8.14	0.905	2.839	18.735	16.879	39.79	-

*Significant at 5%, NS- Non significant, CPE – Cumulative pan evaporation

Mulching levels – (M)

M_1 = with mulching

M_0 = without mulching

Irrigation levels – (I)

L_1 = 0.5 CPE

L_2 = 0.6 CPE

L_3 = 0.7 CPE

L_4 = 0.8 CPE

Table 1b: Effect of different levels of irrigation and mulching on growth, yield and quality of mulberry leaf at harvest (60 DAP)

Treatments	Plant height (cm)	No. of shoots $plant^{-1}$	No. of leaves $plant^{-1}$	Leaf area (cm^2)	Total dry matter (g $plant^{-1}$)	Leaf yield (g $plant^{-1}$)	Leaf yield (kg ha^{-1} yr^{-1})
T_1 - M_1 L_1	90.096	21.05	300.71	113.30	349.91	590.46	41000
T_2 - M_1 L_2	102.44	22.39	307.68	141.96	392.14	623.44	43292
T_3 - M_1 L_3	107.93	24.29	318.48	170.38	398.14	668.46	46418
T_4 - M_1 L_4	136.25	25.24	333.74	220.55	415.53	718.24	49875
T_5 – M_0 L_1	79.78	20.11	293.20	96.33	323.64	555.35	38564
T_6 – M_0 L_2	83.50	21.83	300.20	120.41	379.78	572.50	39755
T_7 - M_0 L_3	92.00	23.10	312.99	135.85	385.09	630.35	43772
T_8 - M_0 L_4	110.30	24.36	322.34	159.58	400.71	653.21	45360
F – test	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	-
S.Em. ±	**2.92**	**0.45**	**1.49**	**7.97**	**7.80**	**6.41**	-

*Significant at 5%, NS- Non significant, CPE – Cumulative pan evaporation

Mulching levels – (M)

M_1 = with mulching

M_0 = without mulching

Irrigation levels – (I)

L_1 = 0.5 CPE

L_2 = 0.6 CPE

L_3 = 0.7 CPE

L_4 = 0.8 CPE