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Effect of Types of Irrigation and Organic Mulches on Growth of Mulberry

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Authors Contribution

V. S. Ramya : Conceptualization of research, designing of the experiments & investigation;
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Abstract

A field experiment was carried out to study the effect of types of irrigation and organic mulches on growth of mulberry at Department of Sericulture, University of Agricultural Sciences, Bangalore during *Kharif* 2021. The experiment was laid out in Factorial Randomized Complete Block Design (FRCBD) with fourteen treatment combinations and three replications. Main plots include two different types of irrigation *viz.,* Surface drip irrigation- I_1 and Subsurface drip irrigation- I_1 at 15-20 cm depth both at 0.75 Cumulative Pan Evaporation (CPE) and Organic mulches (M_1-Mulching with glyricidia leaves, M_2- Mulching with pongamia leaves, M_3- Mulching with neem leaves, M_4-Live mulch with cowpea, M_5- Live mulch with horsegram and M_6- Live mulch with *dhaincha* and M_7-control without mulch, observations were recorded at 30, 45 and 60 Days After Pruning (DAP). The results of the experiment revealed that the subsurface drip irrigation at 0.75 CPE recorded highest shoot length (79.14, 111.38 and 143.33cm, respectively), number of shoots plant^{-1} (15.32, 19.69 and 27.43 no. respectively), number of leaves plant^{-1} (141.72, 252.02 and 350.96 no. respectively) and leaf area (115.45, 165.31 and 115.45 cm^2 respectively). Among mulches live mulch with cowpea showed highest shoot height (90.53, 118.78 and 149.82 cm respectively), number of shoots plant^{-1} (16.10, 21.20 and 25.30 no. respectively), number of leaves plant^{-1} (146.05, 259.81 and 360.96 no. respectively) and leaf area about 119.25, 170.09 and 246.54 cm^2 respectively. However, effect of irrigation methods and different mulches differed non-significantly.

Keywords : V1 Mulberry, Irrigation methods, Organic mulches and Growth parameters

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Mulberry is a hardy, deep rooted and perennial plant with short proliferation period, fast growth rate and plant adapts itself to varied climatic conditions like tropical, subtropical and temperate regions. Quality of mulberry leaves was determined based on fertility status of soil and moisture content of mulberry leaf. Mulberry leaf is the major economic component in sericulture where production of quality leaf per unit area has a direct effect on cocoon quality. Quality of mulberry leaf is influenced by variety, spacing, irrigation levels, nitrogen levels and season (Basanna *et al.,* 1979). The role of leaf moisture in determining productivity of mulberry production is generally recognized and appreciated. Judicious use of water plays an important role for obtaining higher leaf quality and quantity. Moisture content and nutrients in mulberry leaves is considered as one of the most important criteria in assessing the leaf quality (Paul *et al*., 1992). Higher moisture content of mulberry leaf is one of the important criteria which has a direct effect on growth and development of silkworms. It improves ingestion, digestion and also helps in conversion of nutrients in silkworm body.

Mulberry requires about 1.2 - 1.5 ha cm of water per irrigation at an interval of 3 days depending upon the type of soil and season. About 20 irrigations are required per crop of 65 - 70 days' duration to achieve

the maximum leaf yield. Thus, the total water requirement for per crop is 24-30 ha cm and annual requirement for five crops is about 120-150 ha cm of water (Rajaram and Qadri, 2014).

Water is the major source for crop production and is the most limiting factor in Indian Agriculture. Though India has the largest irrigation area, irrigation efficiency has not been achieved more than 40 per cent. Per capita water availability in the country has dropped from 6008 m^3 in 1947 to 1250 m^3 and now is expected to dwindle down to 760 m^3 (Singh, 2006). Among all other inputs, irrigation water has highest impact on mulberry leaf quality and yield. The need of the hour is to maximize the production per unit of water. Hence, further improvement in quality and yield of crop may need to adopt new irrigation systems such as subsurface drip irrigation. Subsurface drip irrigation which supplies water and nutrients directly to the crop root zone. Crops can be 'spoon-fed' with water and nutrients. The spoon feeding characteristic of the subsurface drip irrigation system has a great potential to minimize the water losses. Organic mulches help in soil moisture conservation, slowly decompose and release of nutrients into soil while improving the soil structure. Higher leaf production and productivity is achieved by improved methods of irrigation system along with moisture conservation practices like organic mulching. With this background, current study was undertaken with the objectives to find out best method of irrigation and organic mulching for increased quality and yield of mulberry.

Material and Methods

The experiment was conducted during *kharif* 2021 in well-established V-1 mulberry garden at Department of Sericulture, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bangalore. The field is located at a latitude of 12°582 N and longitude of 77°352 East and at an altitude of 930 m above mean sea level in the Eastern Dry Zone (Zone-5) of Karnataka. The experiment with fourteen treatment combinations *viz.,* methods of irrigation (I_1 - Surface drip irrigation @ 0.75 CPE and I_2 - Subsurface drip irrigation (15-20 cm depth) @ 0.75 CPE), six mulches (M_1-Mulching with glyricidia leaves, M_2- Mulching with pongamia leaves, M_3- Mulching with neem leaves, M_4-Live mulch with cowpea, M_5- Live mulch with horsegram and M_6- Live mulch with *dhaincha*) with M_7- control were laid out in Factorial RCBD design with three replications.

The data on growth parameters at 30, 45 and 60 DAP of crop were recorded in each treatment on randomly selected five plants from each net plot and mean value was worked out. The experimental data collected on growth components of plant were subjected to Fisher's method of Analysis of Variance (ANOVA) as outlined by Panse and Panse, V. G. and Sukhatme (1967). Wherever, F test was significant for comparison among the treatment means, Critical Difference (CD) was worked out. If F test found non-significant, again CD values NS (non-significant) was indicated.

Results and Discussion

The results and discussion on effect of different irrigation methods and organic mulches on growth of mulberry are revealed in the following sub headings.

Shoot Length

The data on shoot length varied significantly due to different treatments at 30, 45 and 60 DAP (Table 1). Significant difference in shoot length was observed among different irrigation methods. Subsurface drip irrigation at 0.75 CPE has recorded highest shoot length (79.14, 111.38 and 143.33cm respectively) over surface drip irrigation at 0.75 CPE (72.84, 107.64 and 137.42 cm respectively). The significant difference in shoot length may be due to supply of water at root zone and minimized weed growth. Similarly, Kombali *et al.,* 2016 reported that subsurface drip irrigation at 100 per cent pan evaporation recorded significantly higher cane length (226.6 cm) and cane girth (.91 cm). Similar studies were reported by Sudhakar *et al.,* 2018 increase in depth of subsurface drip irrigation from ½ ft. to 1½ ft. significantly increased plant height

TABLE 1

Shoot length of mulberry as influenced by different methods of irrigation and organic mulching

Treatments	Shoot length of plant (cm)		
	30 DAP	45 DAP	60 DAP
		Different types of Irrigation (I)	
I_1 - Surface drip irrigation (I_1) @ 0.75 CPE	72.84	107.64	137.42
I_2 - Subsurface drip irrigation (I_2) @ 0.75 CPE	79.14	111.38	143.33
F-test	*	*	*
S.Em. ±	0.71	0.85	0.89
CD at 5 %	2.06	2.47	2.59
		Different types of mulches (M)	
M_1 - Glyricidia leaves	78.93	111.11	142.89
M_2 - Pongamia leaves	75.17	107.98	138.99
M_3 - Neem leaves	68.43	104.30	135.70
M_4 - Live mulch with cowpea	90.53	118.78	149.82
M_5 - Live mulch with Horsegram	80.12	113.92	143.46
M_6 - Live mulch with *Dhaincha*	72.41	108.36	138.51
M_7 - Control (without mulch)	66.35	102.18	133.26
F-test	*	*	*
S.Em. ±	1.32	1.59	1.66
CD at 5 %	5.46	6.54	6.85
		Interaction (I×M)	
T_1 - I_1 M_1	75.43	109.48	140.21
T_2 - I_1 M_2	71.85	105.62	136.66
T_3 - I_1 M_3	66.67	98.92	134.29
T_4 - I_1 M_4	88.90	117.29	147.82
T_5 - I_1 M_5	76.59	112.69	139.43
T_6 - I_1 M_6	69.27	107.96	134.81
T_7 - I_1 M_7	61.17	101.56	128.72
T_8 - I_2 M_1	82.43	112.73	145.57
T_9 - I_2 M_2	78.49	110.33	141.32
T_{10} - I_2 M_3	70.20	109.68	137.11
T_{11} - I_2 M_4	92.16	120.26	151.83
T_{12} - I_2 M_5	83.65	115.14	147.49
T_{13} - I_2 M_6	75.55	108.76	142.20
T_{14} - I_2 M_7	71.53	102.80	137.81
F- test	NS	NS	NS
S. Em±	1.88	2.25	2.35
CD at 5 %	NS	NS	NS

DAP- Days After Pruning; *- Significant; NS- Non significant

from 160.20 to 163.60 cm compared to surface drip irrigation of 157.80 cm.

Shoot length was significantly influenced by different mulches. Live mulch with cowpea has recorded highest shoot length (90.53, 118.78 and 149.82 cm respectively), among mulches lowest shoot length was recorded in neem leaves mulched plot (68.43, 104.30 and 135.70 cm). Similar results were reported by Mas-Ud *et al.,* 2021 who found that among different varieties of cowpea live mulch types, the Padituya live mulch produced the tallest (96 cm) maize plants at vegetative growth and this was significantly higher than the other two living mulch types, with the control producing the shortest plants of 87 cm. The difference in height could be as a result of enhanced soil nutrients (e.g., nitrogen), which is associated with legume plants like cowpea. Interaction on types of irrigation and organic mulches found non-significant with respect to shoot length of mulberry crop. However, T_{11} - I_2M_4 recorded highest shoot length 92.16, 120.26 and 151.83 cm respectively, which is followed by T_4- I_1M_4, which recorded 88.90, 117.29 and 147.82 cm respectively. The least shoot length of 61.17, 101.56 and 128.72 cm respectively was recorded by T_7- I_1M_7.

Number of Shoots Plant^{-1}

The significant difference in number of shoots plant^{-1} were observed among types of irrigation and organic mulches at 30, 45 and 60 DAP (Table 2). Subsurface drip irrigation at 0.75 CPE has recorded a greater number of shoots plant^{-1} (15.32, 19.69 and 27.43 no. respectively) over surface drip irrigation at 0.75 CPE (14.18, 17.95 and 21.51 no. respectively). The significant difference in number of shoots may be due effective utilization of water by crop which is supplied directly to root zone. The results are in confirmation with findings of Seenappa, 2015, reported that number of shoots plant^{-1} increased in subsurface drip irrigation with higher level at 1.0 CPE about 26.42 during harvest. Evaporation loss from surface drip irrigation is 10 per cent of applied water could be saved when drip laterals were placed at 15-30 cm below the soil surface there by crops growth will be enhanced (Evett *et al.,*1995). It has been found that subsurface drip irrigation reduced evaporation from the soil and increased the wetted soil volume and surface area more than surface systems allowing a deep rooting pattern (Phene, 1995).

Subsurface drip irrigation is most advanced method of irrigation for getting more crop growth which enables the application of small amounts of water to the soil through drippers placed below the soil surface with discharge rates generally in same range of surface drip irrigation (ASAE Std., 1999).

Live mulch with cowpea has recorded more number of shoots (16.10, 21.20 and 25.30 no. respectively), among mulches lowest number of shoots was recorded in neem leaves mulched plot (13.90, 18.73 and 24.10 no. respectively).

Similar results were also observed by Boateng *et al.,* 2019, reported that living mulch with Canavalia-grown tomato plants (60 days) had early number of days to 50 per cent flowering when compared to control (65 days). This could be due to higher atmospheric nitrogen fixed to enrich the soil by *Canavalia ensiformis* than the other treatments. Interaction on types of irrigation and organic mulches found non-significant with respect to number of shoots of mulberry crop. However, T11 - I_2M_4 recorded highest number of shoots of 16.73, 22.66 and 28.20 respectively, which is followed by T_4 - I_1M_4, which recorded 15.46, 19.73 and 22.40 respectively. The least number of shoots of 12.60, 16.20 and 20.60 respectively was recorded by T_7- I_1M_7.

Number of Leaves Plant^{-1}

The results on number of leaves plant^{-1} were significantly influenced by types of irrigation and organic mulches at 30, 45 and 60 DAP (Table 3). The data on number of leaves plant^{-1} varied significantly due to different treatments of mulberry crop. Number of leaves plant^{-1} (141.72, 252.02 and 350.96 no. respectively) varied significantly by subsurface drip irrigation at 0.75 CPE over surface drip irrigation at 0.75 CPE (134.26, 244.73 and 339.77 no. respectively). The

TABLE 2

Number of shoots plant^{-1} of mulberry influenced by different methods of irrigation and organic mulching

Treatments	Number of shoots palnt^{-1}		
	30 DAP	45 DAP	60 DAP
		Different types of Irrigation (I)	
I_1 - Surface drip irrigation (I_1) @ 0.75 CPE	14.18	17.95	21.51
I_2 - Subsurface drip irrigation (I_2) @ 0.75 CPE	15.32	19.69	27.43
F - test	*	*	*
S.Em. ±	0.29	0.29	0.31
CD at 5 %	0.85	0.84	0.90
		Different types of mulches (M)	
M_1 - Glyricidia leaves	15.26	19.43	25.60
M_2 - Pongamia leaves	14.23	17.70	23.60
M_3 - Neem leaves	13.90	18.73	24.10
M_4 - Live mulch with cowpea	16.10	21.20	25.30
M_5 - Live mulch with Horsegram	15.333	19.33	25.36
M_6 - Live mulch with *dhaincha*	14.73	17.93	24.23
M_7 - Control (without mulch)	13.7	17.43	23.13
F- test	*	*	*
S.Em. ±	0.54	0.54	0.58
CD at 5 %	2.25	2.23	2.39
		Interaction (I×M)	
T_1 - I_1 M_1	14.80	18.86	23.66
T_2 - I_1 M_2	13.93	17.20	20.53
T_3 - I_1 M_3	13.40	17.33	22.53
T_4 - I_1 M_4	15.46	19.73	22.40
T_5 - I_1 M_5	14.73	18.66	19.66
T_6 - I_1 M_6	14.33	17.66	21.20
T_7 - I_1 M_7	12.60	16.20	20.60
T_8 - I_2 M_1	15.73	20	27.53
T_9 - I_2 M_2	14.53	18.2	26.66
T_{10} - I_2 M_3	14.40	20.13	25.66
T_{11} - I_2 M_4	16.73	22.66	28.20
T_{12} - I_2 M_5	15.93	20.00	31.06
T_{13} - I_2 M_6	15.13	18.20	27.26
T_{14} - I_2 M_7	14.80	18.66	25.66
F - test	NS	NS	NS
S. Em ±	0.77	0.77	0.82
CD at 5 %	NS	NS	NS

DAP- Days After Pruning *- Significant; NS- Non significant

TABLE 3

Number of leaves plant^{-1} of mulberry influenced by different methods of irrigation and organic mulching

Treatments	Number of leaves plant^{-1}		
	30 DAP	45 DAP	60 DAP
		Different types of Irrigation (I)	
I_1 - Surface drip irrigation (I_1) @0.75 CPE	134.26	244.73	339.77
I_2 - Subsurface drip irrigation (I_2) @0.75 CPE	141.72	252.02	350.96
F- test	*	*	*
S.Em. ±	1.38	2.42	2.564
CD at 5 %	4.035	7.051	7.45
		Different types of mulches (M)	
M_1 - Glyricidia leaves	139.45	251.96	355.10
M_2 - Pongamia leaves	134.26	244.07	341.88
M_3 - Neem leaves	131.70	235.30	335.77
M_4 - Live mulch with cowpea	146.05	259.81	360.96
M_5 - Live mulch with Horsegram	142.55	253.59	347.62
M_6 - Live mulch with *Dhaincha*	140	251.26	345.02
M_7 - Control (without mulch)	131.92	242.65	331.21
F-test	*	*	*
S.Em. ±	2.59	4.538	4.79
CD at 5 %	10.67	18.65	19.72
		Interaction (I×M)	
T_1 - I_1 M_1	133.54	247.93	351.13
T_2 - I_1 M_2	128.87	239.26	336.57
T_3 - I_1 M_3	125.62	231.8	327.61
T_4 - I_1 M_4	145.33	256.8	357.26
T_5 - I_1 M_5	140.63	250.92	343.2
T_6 - I_1 M_6	136.02	248.53	340.66
T_7 - I_1 M_7	129.82	237.91	321.95
T_8 - I_2 M_1	145.37	256	359.08
T_9 - I_2 M_2	139.66	248.87	347.186
T_{10} - I_2 M_3	137.79	238.80	343.93
T_{11} - I_2 M_4	146.78	262.83	364.67
T_{12} - I_2 M_5	144.47	256.27	352.05
T_{13} - I_2 M_6	143.98	253.99	349.38
T_{14} - I_2 M_7	134.02	247.38	340.47
F - test	NS	NS	NS
S. Em±	3.67	6.41	6.78
CD at 5 %	NS	NS	NS

DAP- Days After Pruning; *- Significant; NS- Non significant

significant difference in number of leaves may be due to water in close association with rhizosphere zones of mulberry and making use of water efficiently. The results are in line with Gopinath (1994) noticed that in mulberry, higher growth was obtained under irrigated condition and additional mulberry cultivation area coverage under irrigation by using the water saved in drip irrigation was also noticed by the author. Anantha krishna *et al.* (1995) reported that 48 per cent of increased mulberry leaf growth and yield along with 67 per cent of water savings with drip irrigation which equals to irrigation at 40 per cent CPE from open class pan evaporimeter. However, irrigation at 80 per cent CPE value with 33 per cent water saving under drip method of irrigation was found to be ideal for mulberry compared to conventional furrow method of irrigation. The results are in line with Seenappa and Devakumar, 2015 reported that subsurface drip irrigation at higher levels at 1.0 CPE increased number of leaves from 215.11 at 30 DAP to 402.67 at harvest.

Sudhakar *et al.,* 2018, reported that number of leaves of mulberry plant has been increased with increase in depth of subsurface drip irrigation, where number of leaves increased from 274.4 at a depth of ½ ft. to 290.5 at a depth of 1½ ft. The reasons may be the advantages involved in the sub-surface drip irrigation methods. It is noticed that the water infiltration was down word instead of upward due to gravitational forces of the soil. Inline drips laid in varied depths have an advantage over other methods because the moisture regimes are exactly remaining near to the rhizosphere zone leading to constant availability of water thereby increasing growth parameters of mulberry.

Live mulch with cowpea has recorded more number of leaves (146.05, 259.81 and 360.96 no. respectively) where, lowest number of leaves was recorded in neem leaves mulched plot (131.70, 235.30 and 335.77 no. respectively). Similar results were also observed by Boateng *et al.,* 2019, reported that living mulch with Canavalia-grown tomato plants had more number of fruits per tomato plant and second highest was found in cowpea plot where lowest number of fruits found in Mucuna plots. Mulches used as cover crops and intercropping (as live crop grown in between the rows of main crop) provide different benefits in agro-ecologies through competition and allelopathy such as nitrogen fixation, erosion control, improving organic matter, nutrient recycling, pest and weed control and improving soil organism (Khan *et al.,* 2019). Interaction on types of irrigation and organic mulches found non-significant with respect to number of leaves of mulberry crop. However, T_{11} - I_2M_4 recorded highest number of leaves of 146.78, 262.83 and 364.67 respectively, which is followed by T_4- I_1M_4, which recorded 145.33, 256.8 and 357.26respectively. The least number of leaves of 129.82, 237.91 and 321.95 respectively was recorded by T_7- I_1M_7.

Leaf Area (cm^2)

The findings on leaf area (cm^2) were significantly influenced by types of irrigation and organic mulches at 30, 45 and 60 DAP and leaf area varied significantly due to different treatments of mulberry crop. Subsurface drip irrigation @ 0.75 CPE increased leaf area (115.45, 165.31 and 241.73 cm^2 respectively) varied significantly over surface drip irrigation @ 0.75 CPE (108.03, 149.29 and 223.52 cm^2 respectively). The above results were in conformity with the findings of Sudhakar *et al.,* 2018. Leaf area of mulberry plant has been increased with increase in depth of subsurface drip irrigation where leaf area increased from 190.2 at ½ ft. to 198.9 cm^2 at 1½ ft. This might be due to increased levels of water infiltration in the form of vertical, horizontal water percolation and water holding capacity was noticed in all the sub-surface drip irrigations compared to the traditional methods of irrigations (flood & surface drip irrigations) and drip irrigation method will not only save the irrigation water, reduce the frequency of irrigation and seepage accompanied with plant nutrients but they are also effective because of their close association with rhizosphere zones of mulberry and making use of water efficiently. Subsurface drip has also proven to be an efficient irrigation method with potential advantages of high water use efficiency,

TABLE 4

Leaf area of mulberry as influenced by different methods of irrigation and organic mulching

Treatments	Leaf area (cm^2)		
	30 DAP	45 DAP	60 DAP
		Different types of Irrigation (I)	
I_1 - Surface drip irrigation (I_1) @0.75 CPE	108.03	149.29	223.52
I_2 - Subsurface drip irrigation (I_2) @0.75 CPE	115.45	165.31	241.73
F- test	*	*	*
S.Em. ±	1.31	2.74	1.31
CD at 5 %	3.83	7.98	3.83
		Different types of mulches (M)	
M_1 - Glyricidia leaves	112.37	153.49	232.08
M_2 - Pongamia leaves	103.98	150.34	228.50
M_3 - Neem leaves	99.85	143.76	223.07
M_4 - Live mulch with cowpea	119.25	170.09	246.54
M_5 - Live mulch with Horsegram	117.27	165.06	236.91
M_6 - Live mulch with *Dhaincha*	114.67	161.98	232.38
M_7 - Control (without mulch)	114.78	156.41	228.88
F-test	*	*	*
S.Em±	2.46	5.14	4.59
CD at 5 %	10.13	21.13	18.87
		Interaction (I×M)	
T_1 - I_1 M_1	110.50	150.55	220.50
T_2 - I_1 M_2	100.75	146.62	217.56
T_3 - I_1 M_3	95.88	138.80	213.81
T_4 - I_1 M_4	115.54	156.90	239.46
T_5 - I_1 M_5	112.69	153.57	226.76
T_6 - I_1 M_6	110.55	151.08	224.23
T_7 - I_1 M_7	110.33	147.55	222.33
T_8 - I_2 M_1	114.25	156.43	243.66
T_9 - I_2 M_2	107.22	154.06	239.44
T_{10} - I_2 M_3	103.82	148.72	232.33
T_{11} - I_2 M_4	122.96	183.28	253.63
T_{12} - I_2 M_5	121.85	176.55	247.06
T_{13} - I_2 M_6	118.80	172.89	240.54
T_{14} - I_2 M_7	119.24	165.27	235.44
F- test	NS	NS	NS
S. Em±	3.48	7.26	6.49
CD at 5 %	NS	NS	NS

DAP- Days After Pruning; *- Significant; NS- Non significant

fewer weed and disease problems, less soil erosion, efficient fertilizer application, maintenance of dry areas for tractor movement at any time flexibility in design and lower labour costs compared to conventional drip irrigation.

Live mulch with cowpea has recorded higher leaf area (119.25, 170.09 and 246.54 cm^2 respectively) over neem leaves mulched plot (99.85, 143.76 and 223.07 cm^2 respectively). Similar results reported by Boateng *et al.,* 2019, fruit weight per plant was highest in Canavalia-grown tomato plants (535 g) and lowest in Mucuna-grown tomato plants (302 g) and there were significant differences between treatment.

Legumes have been found to enhance soil fertility and increase crop yield. In a similar work, (Chaudary *et al.,* 1991) found that legumes could have multiple uses including use as cover crops, live mulch or food crops. The legumes can generate considerable quantity of organic matter (up to 80 q ha^{-1}) possessing about 40 kg of nitrogen ha^{-1} of which about is 2/3 being fixed from atmosphere by bacteria. Interaction on types of irrigation and organic mulches found non-significant with respect to leaf area of mulberry crop. However, T_{11} - I_2M_4 recorded highest number of leaves of 122.96, 183.28 and 253.63 respectively, which is followed by T_4- I_1M_4, which recorded 115.54, 156.90 and 239.46 respectively. The least number of leaves of 110.33, 147.55 and 222.33 respectively was recorded by T_7- I_1M_7.

Irrigation is an important tool among all other agricultural inputs. However, method of irrigation plays an important role in determining the growth and yield of mulberry, thus subsurface drip irrigation showed better results over surface drip irrigation because it is placed below soil surface and near to rootzone of mulberry which helps in absorption of nutrients and reduction in evaporation loss directly from soil surface. Organic mulches played an important role by covering soil surface, conserving soil moisture, by fixing nitrogen from atmosphere, improving the organic matter in soil intern helps to get successful mulberry crop production.

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References

Ananthakrishna, K. H., Arun Sarpeshkar, M. and Muralidhara, H. R., 1995, Drip irrigation for mulberry cultivation. *Indian Silk*, **34** (3) : 17 - 19.

Asae Std., 1999, Soil and water terminology. S., 526.1. ASAE standards. *American Soc. Agric. Eng.,* St. Joseph, MI

Basanna, H. M., Kodandaram, M. S. and Srinivasan, F. B., 1979, Studies on the chemical composition of new mulberry cultivars in different agronomical treatments. Annual Report, Central Sericulture Research and Training Institute (CSR&TI), Mysore, pp. : 4042.

Boateng, S. K., Mensah1, A. O. and Allotey, D., 2019, The effect of leguminous cover crops on growth and yield of tomato. *Int. J. Horti. Agri. Foodsci.,* **3** (5) : 2456 - 8635.

Choudhury, P. C., Das, P. K., Ghosh, A. and Mathur, V. B., 1991, Green manuring cum dry weed mulching for improvement of soil fertility and soil moisture conservation. *Ann. Rep.,* Central Sericulture Research and Training Institute (CSR&TI), Mysore, pp. : 13.

Evett, S. R., Howell, T. A. and Schneider, A. D., 1995, April. Energy and water balances for surface and subsurface drip irrigation: a comparison point and area sources. *Irrig. Sci.,* **22** : 171 - 176.

Gopinath, G. R., 1994, Drip irrigation for mulberry gardens. *Indian silk,* **33** (2) : 27 - 31.

Khan, I. A., Rehman, O. U., Khan, S. A., Samady, H. A. and Alzahrani, Y., 2019**,** Effect of Different Herbicides, Plant extracts and mulches on yield and yield components of maize. *Planta Daninha*, **38** : 112 - 118.

KOMBALI, G., SHESHADRI, T., NAGARAJU, THIMMEGOWDA, M. N., BASAVARAJA, P. K. AND MALLIKARJUNA, G. B., 2016, Performance of sugarcane under varied levels of irrigation and nutrients through subsurface drip fertigation. *Mysore. J. Agri. Sci.,* **50** (2) : 290 - 293.

MAS-UD, M., DOKURUGU, F. AND KABA, J. S., 2021, Effectiveness of cowpea (*Vigna unguiculata* L.) living mulch on weed suppression and yield of maize (*Zea mays* L.). *Open Agriculture*, **6** : 489 - 497.

PANSE, V. G. AND SUKHATME, P. V., 1967, Statistical methods for agricultural workers. *Indian Council of Agricultural Research*, New Delhi.

PAUL, D. C., RAO, G. S. AND DEB, D. C., 1992, Impact of dietary moisture on nutritional indices and growth of *Bombyx mori* and concomitant larval duration. *J. insect Physiol.,* **38** (3) : 229 - 235.

PHENE, C. J., 1995, The sustainability and potential of subsurface drip irrigation. In: Micro irrigation for a change World, Eds F. R. Lamn. Orlando, Florida, USA. pp. : 359 - 367.

RAJARAM, S. AND QADRI, S. M., 2014, Computation of irrigation water requirements, its managements and calendaring in mulberry crop for sustainable sericulture under Tamil Nadu conditions. *Int. J. Engg. And Sci.,* **4** (1) : 1 - 19.

SEENAPPA, C. AND DEVAKUMAR, N., 2015, Effect of different methods and levels of irrigation and mulching on growth and yield of mulberry in eastern dry zone of Karnataka. *Mysore. J. Agri. Sci*, **49** (2) : 206 - 210.

SEENAPPA, C., 2015, Enhancing water productivity in mulberry and cocoon production in eastern dry zone of Karnataka. *Uni. Agri. Sci. Bang., Thesis.,* pp. : 76 - 87.

SINGH, D. K. AND RAJPUT, T. B. S., 2006, Response of lateral placement depths of subsurface drip irrigation on okra (*Abelmoschus esculentus*). *Int. J. Plant Prod*. **1** (1) : 73 - 84.

SUDHAKAR, P., HANUMANTHARAYAPPA, S. K., SWAMY GOWDA, M. R., JALAJA S., KUMAR AND SIVAPRASAD, V., 2018, Impact of micro irrigation methods on Mulberry (*Morus alba* L.) leaf quality and production*, Int. J. Pure App. Biosci*. **6** (3) : 332 - 339.