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Quality And Quantity Of Mulberry Leaf Influenced By Different Methods, Levels Of Irrigation And Mulching During Rabi In Eastern Dry Zone Of Karnataka

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Abstract

A field experiment wasconductedat College of Sericulture, Chintamani, Chickaballapur district, Karnataka, India during rabi2013 to know the influence of different methods, levels of irrigation and mulching on quality and quantity of mulberry leaf in Eastern Dry Zone (EDZ) of Karnataka. The results revealed that the mulberry leaf quality and quantity weresignificantly influenced by different methods, levels of irrigation and mulching. Among the methods and levels of irrigation, subsurface drip irrigation at 0.8 CPE recorded higher chlorophyll, relative water,protein, total carbohydrate content at harvest and leaf yield (8.64, 69.69%, 23.56%, 17.29% and 38920kg ha^{-1} yr^{-1}) than surface drip at 1.0 CPE (7.42, 67.06%,18.78%, 16.93% and 35012kg ha^{-1} yr^{-1}) and micro spray jet at 1.0 CPE (7.98, 67.63%,20.24%, 17.05% and 35617kg ha^{-1} yr^{-1}). Maximum chlorophyll, relative water, protein, total carbohydrate content at harvest and leaf yield (7.19, 67.21%, 17.09%, 16.66% and 35336 kg ha^{-1} yr^{-1}) was noted in mulching than without mulching treatment. These results clearlyshowedthat subsurface drip irrigation at 0.8 CPE and mulching increased the quality and quantity of mulberry leaf than surface drip and micro spray jet irrigation at 1.0 CPE by saving 20 per cent of water. In the coming years, subsurface drip irrigation may be more appropriate to realise higher quality and quantity of mulberry leaf in EDZ of Karnataka.

Key words: Surface drip;Subsurface drip; Micro spray jet; CPE; Mulching; Mulberry

I. Introduction

Mulberry is cultivated by farmers for its leaves, the sole food for silkworm (*Bombyx mori* L) for commercial production of raw silk in Sericulture Industry. As mulberry is a perennial crop can be maintained for many years, selection of land, follow-up of recommended package of practices and water management are inevitable for producing quality leaf concomitant productivity throughout. Further the quality of mulberry leaves as single factor contributes about 38.2% for the success of silkworm crop (Miyashita, 1986), adequate supply of water and nutrients into soil is very much essential.

In India, mulberry is cultivated in an area of 2.82 lakh hectares giving livelihood to about 8.18 lakh sericulture families in 50,918 villages. Out of the total mulberry area, 80 per cent is under irrigated condition. In Karnataka, out of 1.66 lakh hectares of mulberry area, 95 per cent of mulberry gardens are under irrigated condition (Anon., 2006); indicating the importance of irrigation in mulberry crop production. Quality of mulberry leaves was determined mainly based on moisture content (Kumar *et al*., 1996). Mulberry leaf is the major economic component in sericulture and quality leaf produced per unit area has a direct effect on cocoon quality. Judicious use of water to be followed for obtaining higherleaf quality and quantity. Higher moisture content of mulberry leaves is one of the important factors and has a direct effect on growth and development of silkworms.

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Moisture content in mulberry leaves improves their ingestion, digestion and also the conversion of nutrients in silkworm. Water content in mulberry leaves is considered as one of the criteria in estimating the leaf quality (Paul *et al.*, 1992). Miyashita (1986) stated that the improvement of leaf quality than the productivity of leaves is immediately required for the stability of cocoon crops.

Leaf quality is an important factor used for selection of superior varieties of silkworms (Bongale*et al*., 1997).It is fact that, in sericulture more than 60% of total cost of cocoon production goes towards mulberry production alone. Hence, in recent years maximum attention has been given for the improvement of quality and quantity in mulberry. Growth and development of silkworm and cocoon yield are mainly influenced by yield and nutritional quality of mulberry leaf used (Yokoyama, 1963).

Mulching is also one of the important agronomic practice essential for conserving the soil moisture, suppressing the weeds, improving soil fertilityand modifying the soil physical environment(Yoo-Jeong*et al*., 2003). Different types of mulches have been used toobtain good crop yield and quality.

Eastern Dry Zone (EDZ) of Karnataka mainly depends on rainfall and underground water sources due to lack of perennial water sources for crop production. Chickaballapur and Kolar districts in EDZ of Karnataka in particular, the mulberry farmers found many advantages in surface drip irrigation than flood irrigation in mulberry. Sudden depletion of water table due to over exploitation leads to shortage of water is the major constraint than any other crop production technologies. Presently, mulberry farmers need water saving technologies and good marketing facilities in EDZ.

Water is the critical and costly input for mulberry 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 capita water availability in the country has dropped from 6008 m^3 in 1947 to 1250 m^3 now and is expected to dwindle down to 760 m^3 (Singh, 2006). Among all the agronomical inputs, irrigation water has highest impact on mulberry leaf quantity and quality. The need of the hour isto maximize the production per unit of water. Hence, further improvement in quality and quantity of crops may need to adopt new irrigation systems such as subsurface drip irrigation. Subsurface drip irrigation supplies water and nutrients directly to the crop root zone. Crops can be “spoon-fed” water and nutrients. The spoon-feeding characteristic of the subsurface drip irrigation system has a great potential to minimize the water losses. In the above context, present field study was conducted to evaluate suitable methods and levels of irrigationrequired to produce better quality and quantity of mulberry leaf inEDZ of Karnatakasince this zone is traditional sericulture belt.

II. Materials and Methods

The study was conducted during winter 2013 in pre-established irrigated Victoria-1 mulberry garden at College of Sericulture, Chintamani, Chickaballapur district, Karnataka state, India. Climate is semi-arid, tropical with hot dry summer and cold winter and it falls in EDZ of Karnataka. Annual rainfall is 650-700 mm.The experiment was laid out in a double split plot design with three replications and 18 treatments combination comprises three methods of irrigation (I_1= surface drip, I_2 = subsurface drip and I_3 = micro spray jet), mulching (M_1 = with mulching and M_0= without mulching) and three levels of irrigation (L_1 = 0.6 CPE, L_2 = 0.8 CPE and L_3 = 1.0 CPE). In drip irrigation method in-line drip laterals were connected to sub-mains at a spacing of 1 m and laid on surface all along the rows and in-line drippers are placed on lateral tubes with discharge rate of 2.5 lph. Plots irrigated with subsurface drip irrigation system, in-line drip lateral tubes were buried into the soil at 5-10 cm away from rows to a depth of 15-20 cm. In micro spray jet irrigation system, micro spray jets were fixed at a spacing of 1 m with 30 cm raisers at the middle of four plants. First one blank irrigation was given to all plots two days prior to starting of experiment to bring the soil moisture to field capacity. Subsequent irrigation were given once in three days and different levels of irrigation were imposed based on cumulative pan evaporation through climatological approach

(Jenson *et al.*, 1961). Fully dried weeds and other crop residues were spread over the ground as mulch at the rate of 30 kg per treatment. Recommended FYM of 15 t ha^{-1} was incorporated in to the soil at ploughing and nitrogen, phosphorus and potassium (350:120:120 NPK kg ha^{-1}) were supplied to all the plots through fertigation. The cultural practices were followed as per the recommended package of practices (Dandin *et al*., 2003).Five plants were randomly selected in each treatment for recording observations on growth and leaf yield at 30, 45 DAP and at harvest. Data was statistically analyzed by adopting O.P. Stat software. Treatment means and interaction effects were compared using critical difference at 5% level of significance.

III. Results and Discussion

Leaf quality: Mulberry leaf quality was significantly influenced by different methods, levels of irrigation and mulching during *rabi* in EDZ of Karnataka (Table 1). Subsurface drip irrigation at 0.8 CPE recorded higher chlorophyll, relative water, protein and total carbohydrate content (8.64, 69.69%, 23.56% and 17.29%) compared to surface drip at 1.0 CPE (7.42, 67.06%, 18.78% and 16.93%) and micro spray jet at 1.0 CPE (7.98, 67.63%, 20.24% and 17.05%). This might be due to subsurface drip irrigation reducing the evaporation losses and spoon feeding of water and nutrients to plants compared to surface drip and micro spray jet irrigation methods. Chlorophyll content is very important for quantifying the photosynthetic efficiency. These results are in promised with those of El-Fawakhry (2004)stated that the drip irrigation is important in increasing the availability and absorption of nitrogen and other minerals in the plant, thereby increasing the chlorophyll content in the leaves. Subsurface drip irrigation was more efficient than surface drip irrigation for enhancing quantitative growth parameters and nutrient concentrations in plants and fertility in the soil was reported by Khalid (2012).Khattab*et al*., (2011)also observed that the augmentation in irrigation rate was concurrent with an increase in chlorophyll, could be attributed to increased nutrient uptake especially N and Mg as a consequence of improved soil moisture. Higher levels of irrigation at 0.9 CPE showed higher leaf moisture and nitrogen content in mulberry(Bongale and Siddalingaswamy, 2003).

Further, these results are in accordance with findings of Long Dominic and Thomos Spears (2003) reported that subsurface drip may also help in increasing quality parameters due to improved irrigation, nutrients and energy use efficiencies. Subsurfacedrip irrigation is potentially more efficient in arid and semi-arid regions of India because it provides water directly to the root zone and minimizing evaporation losses.Higher moisture content of mulberry leaves is one of the important factors and has a direct effect on growth and development of silkworms. Moisture content in mulberry leaves favourably affects their ingestion, digestion and also the conversion of nutrients in silkworm. Water content in mulberry leaves is considered as one of the criteria in estimating the leaf quality (Paul *et al.*, 1992).

Quality parameters of mulberry leaf like chlorophyll, relative water, protein and total carbohydrate content (7.19, 67.21%, 17.09% and 16.66%)weresignificantly influenced by mulching and recorded higher than without mulching.This might be due to fact that mulches conserve the soil moisture, increases the water use efficiency, microbial population and the nutrient uptake of the plants and thereby improved the quality status of mulberry. These results are confirmed byRamakrishna *et al*., (2006) that the beneficial aspects of mulching includes conservation of moisture, controls weeds and moderate soil temperature for better root growth and higher quality. Mulching also increase the availability of more moisture and reduced soil temperature which increases the activity of the soil microbes might also helped in increasing quality parameters. These results are in confirmation with the findings of Das *et al*. (1990) in mulberry, Gangawar*et al.* (2000) in mulberry and Kumara *et al.* (2014) in stevia.

Leaf quantity: Different methods, levels of irrigation and mulching were significantly influenced on mulberry leaf yieldduring *rabi* in EDZ of Karnataka presented in Table 2. Higher mulberry leaf yield of 38920kg ha^{-1} yr^{-1} was recorded in subsurface drip irrigation at 0.8 CPE than

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surface drip at 1.0 CPE (35012 kg ha^{-1} yr^{-1}) and micro spray jet at 1.0 CPE (35617kg ha^{-1} yr^{-1}). Subsurface drip irrigation had recorded higher growth and yield parameters resulted in higher leaf yield than surface drip and micro spay jet irrigation methodsmight be due to the availability of more moisture at root zone throughout the crop growth period. These results are in accordance with Ayars*et al*. (1999) have recorded 22 per cent higher yields in row crops with subsurface drip irrigation than surface flood irrigation. It was also observed that subsurface drip irrigation creates more suitable environment in the root zone area of the plants for better growth and production (Al-Omran*et al.*, 2004). Subsurface drip system is used to provide water to plant roots while maintaining relatively dry soil surface, which ensures that applied water will be available to the plant root system. This is practically important in sandy and sandy loamy soils (ASAE Std., 1999). According to Evett*et al*. (1995), evaporation losses of 8.1 cm water from surface drip irrigation could be saved when drip laterals were placed 15-30 cm below the soil surface.

Similarly, Palese*et al*. (2009) and Hussein (2008) also noticed that increased yield of mulberry leaf might be due to increase in photosynthetic rate as a result of more absorption of available nutrients, which cause increase in growth and photosynthesis efficiency. Subsurface drip irrigation is a very precise irrigation method, both in the delivery of water and nutrients to desired locations and the timing and frequency of applications for optimal plant growth was reported by Camp (1998). Subsurface drip irrigation provides incremental application of nitrogen and water to the plants. With good management, this has been reported to reduce NO_3 leaching and contamination of groundwater in lettuce production (Thompson and Doerge, 1996). Potato yield was increased by 27 per cent with subsurface drip irrigation over sprinkler irrigation, while reducing irrigation requirement by 29 per cent (De Tar *et al*., 1996).

Significantly higher leaf yield of 35336 kg ha^{-1} yr^{-1} was recorded in mulching treatment than without mulching.Similar results were also reported by Ramakrishna *et al*., (2006) that the beneficial aspects of mulching includes conservation of moisture, controls weeds and moderate soil temperature for better root growth and higher crop yield. Mulching also increase the availability of more moisture and reduced soil temperature which increases the activity of the soil microbes might also helped in increasing yield and quality parameters. However, the chlorophyll, relative water content and leaf yield were found non-significant due to the interaction effect between methods and levels of irrigation and mulching.

IV. Conclusion

Subsurface drip irrigation recorded higher quality and quantity of mulberry leaf than surface drip and micro spray jet irrigation due to spoon feeding of nutrients and water to plants besides saving 20% of water. Hence, subsurface drip irrigation may be appropriate and efficient method to achieve good quality and quantity of leaf in EDZ of Karnataka under water scarce situations.

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Table 1: Quality of mulberry leaf as influenced by different methods, levels of irrigation and mulching

Treatments	Chlorophyll			RWC (%)			Protein (%)			Total Carbohydrate (%)		
	Mulching (M)											
	M_1	M_0	Mean	M_1	M_0	Mean	M_1	M_0	Mean	M_1	M_0	Mean
Irrigation Methods (I)												
I_1	6.66	6.22	**6.44**	66.13	65.05	**65.59**	15.05	13.55	**14.30**	16.47	16.15	**16.31**
I_2	8.12	7.95	**8.03**	69.09	68.55	**68.82**	19.87	19.11	**19.49**	16.96	16.87	**16.91**
I_3	6.79	6.55	**6.67**	66.41	64.81	**65.61**	16.34	13.63	**14.99**	16.56	16.23	**16.39**
Mean	**7.19**	**6.91**		**67.21**	**66.14**		**17.09**	**15.43**		**16.66**	**16.42**	
	S.Em±	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**	
Irrigation Methods (I)	0.09	0.36		0.80	NS		0.08	0.32		0.11	0.43	
Mulching (M)	0.11	NS		0.39	NS		0.11	0.39		0.12	NS	
I x M	0.19	NS		0.67	NS		0.19	0.67		0.21	NS	
Levels of Irrigation (L)												
L_1 **0.6 CPE**	5.76	5.59	**5.68**	64.39	63.30	**63.84**	10.33	9.08	**9.70**	15.96	15.67	**15.82**
L_2 **0.8 CPE**	7.29	7.04	**7.17**	67.61	66.75	**67.18**	18.71	17.21	**17.96**	16.77	16.60	**16.68**
L_3 **1.0 CPE**	8.52	8.08	**8.30**	69.63	68.37	**69.00**	22.23	20.00	**21.12**	17.26	16.98	**17.12**
Mean	**7.19**	**6.91**		**67.21**	**66.14**		**17.09**	**15.43**		**16.66**	**16.42**	
	S.Em±	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**	
Levels of Irrigation (L)	0.12	0.34		0.44	1.28		0.22	0.65		0.15	0.45	
M x L	0.16	NS		0.62	NS		0.31	NS		0.22	NS	
	Levels of Irrigation (L)											
	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Irrigation Methods (I)												
I_1	5.57	6.32	7.42	64.05	65.66	67.06	9.87	14.27	18.78	15.75	16.27	16.93
I_2	5.97	8.64	9.50	64.47	69.69	72.30	10.58	23.56	24.33	16.07	17.29	17.38
I_3	5.49	6.55	7.98	63.02	66.19	67.63	8.67	16.05	20.24	15.64	16.49	17.05
	S.Em±	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**	
I x L	0.20	0.58		0.76	2.22		0.39	1.12		0.27	NS	
I x M x L	0.28	NS		1.08	NS		0.54	NS		0.38	NS	

C.D. @ 5%
DAP = Days after pruning
I_1 = Surface drip
CPE = Cumulative pan evaporation
NS = Non-significant
M_1 = With mulching
I_2 = Subsurface drip
RWC = Relative water content
M_0 = Without mulching
I_3 = Micro spray jet

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Table 2:Quantity of mulberry leaf as influenced by different methods, levels of irrigation and mulching

Treatments	Leaf yield								
	Per plant (g plant^{-1})			Per crop (kg ha^{-1} crop^{-1})			Per year (kg ha^{-1} yr^{-1})		
	Mulching (M)								
	M_1	M_0	Mean	M_1	M_0	Mean	M_1	M_0	Mean
Irrigation Methods (I)									
I_1	663.23	642.05	**652.64**	6632	6420	**6526**	33161	32102	**32632**
I_2	789.72	756.58	**773.15**	7897	7566	**7731**	39486	37829	**38657**
I_3	667.18	644.01	**655.60**	6672	6440	**6556**	33359	32201	**32780**
Mean	**706.71**	**680.88**		**7067**	**6809**		**35336**	**34044**	
	S.Em±	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**	
Irrigation Methods (I)	22.93	89.54		229	895		1146	4476	
Mulching (M)	11.66	NS		117	NS		583	NS	
I x M	20.19	NS		202	NS		1009	NS	
Levels of Irrigation (L)									
L_1 0.6 CPE	620.78	594.51	**607.65**	6208	5945	**6076**	31039	29726	**30382**
L_2 0.8 CPE	717.80	687.49	**702.64**	7178	6875	**7026**	35890	34375	**35132**
L_3 1.0 CPE	781.55	760.63	**771.09**	7815	7606	**7711**	39077	38031	**38554**
Mean	**706.71**	**680.88**		**7067**	**6809**		**35336**	**34044**	
	S.Em±	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**	
Levels of Irrigation (L)	13.10	38.24		131	382		655	1912	
M x L	18.52	NS		185	NS		926	NS	
	Levels of Irrigation (L)								
	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Irrigation Methods (I)									
I_1	597.93	659.74	700.24	5979	6597	7002	29897	32987	35012
I_2	640.35	778.40	900.70	6404	7784	9007	32017	38920	45035
I_3	584.67	669.79	712.34	5847	6698	7123	29233	33490	35617
	S.Em±	**C.D.**		**S.Em±**	**C.D.**		**S.Em±**	**C.D.**	
I x L	22.69	66.24		227	662		1134	3312	
I x M x L	32.08	NS		321	NS		1604	NS	

C.D. @ 5% M_1 = With mulching M_0 =Without mulching
I_1 = Surface drip I_2 = Subsurface drip I_3 = Micro spray jet
NS = Non-significant CPE = Cumulative pan evaporation