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Feasibility of different mulches on growth and yield of mulberry, *Morus alba* L.

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Abstract
Studies were made to know the feasibility of different mulches on growth and yield of mulberry (variety V_1). All the growth and yield parameters of mulberry were significantly superior in *Gliricidia* mulched plots compared to other mulches tested during rainy and winter seasons. *Gliricidia* mulched plots resulted in highest leaf yield (384.76g and 354.34g), plant height (195.87 and 184.83cm), number of branches per plant (24.19 and 19.70), number of leaves per plant (201.27 and 176.50), single leaf area (195.18 cm^2 and 189.61cm^2) and leaf to shoot ratio (15.97 and 14.22) during rainy and winter seasons, respectively. The leaf moisture content, moisture retention capacity of leaves and the nutrient content of the leaves are also superior in the mulberry plots mulched with *Gliricidia.*

Keywords: *Morus alba,* mulches, growth and yield

1. Introduction
Mulberry (*Morus alba* L.) is an important food plant of silkworm, *Bombyx mori* L. The mulberry leaf yield and quality depend on the soil type, plant variety, availability of plant nutrients and agro-ecological conditions, which reflects on the quality of silk production. Mulching is one of the agronomic practices which have influence on the plant growth and yield. Mulch is a porous or non-porous material spread on soil surface in order to obtain beneficial effect on soil environment and crop productivity. According to Jacks *et al*. (1955) [6], the English word mulch was derived from the German word 'Molsch' meaning 'soft to decay'. On the basis of materials used, the mulches may be classified as dust mulch, organic mulch, synthetic or chemical mulch, gravel or sand mulch etc. Mulches have several advantages when they are applied on soil surface. Mulches not only conserve soil moisture through runoff control, increase infiltration, decrease evaporation and help in weed control but affect the soil temperature through radiation shielding, heat conduction and trapping and evaporation cooling. They also increase the soil nutrients through organic matter addition, nitrification and mineral solubility, improve soil structure and increase microbial and soil fauna. Mulches absorb the impact of falling raindrops and reduce dispersion and sealing. Decomposed products of the organic mulches add to the soil fertility. The conservation of soil moisture due to plants and thereby the growth and leaf yield of the plant. The investigation was carried out to find out the best mulch which has positive effects on growth, yield and quality parameters of mulberry.

2. Material and Methods
The investigation was carried out at Department of Sericulture, Gandhi Krishi Vignana Kendra (GKVK), University of Agricultural Sciences, Bengaluru during 2014-2015 to study the feasibility of different mulches on growth and yield of mulberry (variety V_1). Mulches of *Gliricidia*, weed, forest litter, mulberry twigs, polythene and shade net were evaluated for their effects on growth and yield of V_1 Mulberry. The treatments were replicated thrice. The established mulberry garden was dug twice with the help of spade to attain fine tilth. The bunds were reconstructed and each plot was levelled before the imposition of treatments.
Pruning of mulberry was done before mulching, the mulberry crop was pruned to the height of 15-30 cm above ground level (bottom pruning). Fertilizer was applied at root zone and mixed well into the soil. A common fertilizer dose of NPK at 50:50:50 kg/hectare was applied through urea (46%N), single super phosphate (16%P_2O_5) and Murate of potash (60%K_2O). The mulch material was collected and properly dried in the sun. The completely dried mulch material was applied to an extent of 5cm thickness on the surface of the soil in mulberry plot so as to give a complete coverage. The crop was harvested at an interval of 60 days once. Harvesting of leaves was done by hand picking. Further, ten plants were labelled for recording biometric observations of mulberry. At the end of each harvest, leaf yield per plant was recorded.
To record all the growth and yield parameters of mulberry, ten plants were selected at random and labelled. Observations were made on plant height (cm), number of branches per plant, number of leaves per plant, leaf to shoot ratio, leaf area (cm^2) and leaf yield per plant (g). The data obtained was analysed by Two way ANOVA following randomized complete block design.
To estimate the moisture content of leaf, leaf samples were collected from plants and immediately transferred to polythene bags to prevent moisture loss, the collected samples were dried at room temperature for 3 days. Later on the samples were dried at 70^0C and the difference in the moisture percentage was calculated by using the formula, moisture per cent = (fresh weight of leaf - dry weight of leaf) x 100 / fresh weight of leaf. Moisture retention capacity (%) upto 24 hours after the harvest of leaves at every three hours duration was also estimated. N, P and K content of the leaves was estimated by using the methodology suggested by Jackson (1973) [7] .The data obtained was analysed by Two

way ANOVA following randomized complete design.

3. Results and Discussion

3.1 Effects of different types of mulches on growth and yield parameters of V_1 mulberry

Significantly higher leaf yield was recorded in *Gliricidia* mulched plots (384.76 g and 354.34 g) during rainy and winter season. This might be due to maximum plant height (195.87 and 184.83cm), number of branches per plant (24.19 and 19.70), number of leaves per plant (201.27 and 176.50), single leaf area (195.18 cm^2 and189.61 cm^2) and leaf to shoot ratio (15.97 and 14.22), respectively. However, lowest plant height (168.26 and 143.59 cm), number of branches per plant (15.33 and 9.46), number of leaves per plant (173.74 and 135.91), leaf to shoot ratio (11.39 and 8.67) and leaf yield (307.94g/plant and 293.85 g/plant) was recorded in control plots during both the seasons.

The increase growth parameters of mulberry was significant due to better soil moisture retention, creation of favourable soil temperature, suppression of weed growth, improved soil structure, higher status of nutrient in soil and well development of root system. Those findings are in agreement with reports of Jacks *et al*. (1955) [6], Gangawar *et al*. (2000)[4] who reported that paddy straw mulch to mulberry showed maximum leaf yield 46% compared to Sorghum (32.4%) and blackgram mulch (23.08%) over control. Similar findings were also reported by Purohit *et al*. (1990) [10] who observed that black polythene mulch, paddy straw and dry mulberry twig as mulches improved the leaf yield by 48.1, 35.8 and 24.2%, respectively over control. Similar findings are in conformity with Shashidhar *et al*. (2009) [13] reported that, average foliage yield per hectare of four crops was found highest in paddy straw mulched plots (3800.34kg/ha) followed by silkworm bed waste mulch (3674.83 kg/ha), sunhemp mulch (3651.16kg/ha) over other treatments however, lowest yield of mulberry was recorded in no mulch (2946.33kg/ha). In control plots the growth parameters were less. It is because of deficit of soil moisture due to evaporation from bare soil and profused weed growth, which compete with mulberry crop for water and nutrients thus preventing plants to put forth normal growth. Cleland (1971) [2] reported that moisture deficit may result in poor cell division and cell elongation and ultimately results in poor growth.

3.2 Effects of different types of mulches on quality parameters of V_1 mulberry

The leaf moisture content and moisture retention capacity at 3,6,12 and 24 hours differed significantly in both rainy and winter season at 60 DAM as influenced by different mulches. In all harvests *Gliricidia* mulched plots recorded higher leaf moisture content (74.77% and 69.97%) and moisture retention capacity at 3 hours (72.17% and 65.30%), 6 hours (70.68% and 63.18%), 12 hours (67.28% and 61.04%) and 24 hours (61.77% and 53.72%) respectively in both rainy and winter season. While lowest leaf moisture content (70.99% and 61.20%) and moisture retention capacity at 3 hours (68.64% and 60.36%), 6 hours (67.21% and 58.81%), 12 hours (64.23% and 57.53%) and 24 hours (56.50% and 50.06%) was recorded in control plots in both rainy and winter season. These findings are in conformity with findings of Gangawar *et al*. (2000) [4] who reported that maximum leaf moisture content was observed in paddy straw mulch (72.10 and 72.80%, respectively) both S_1 and K_2 varieties of mulberry followed by blackgram and sorghum mulching over control. This was due to more utilization of conserved moisture and nutrients by plants under paddy straw mulch. Similar results were also obtained by Purohit *et al*. (1992) [10] the highest leaf moisture content was recorded with Ulu grass mulch and followed by coconut leaf and water hyacinth mulch over control. This may be due to the fact that plant utilized the conserved soil moisture with increased water use efficiency under mulched conditions. These results are in harmony with those obtained by Kashiviswanathan *et al*. (1971) [8]. It is clear from the study that conservation of soil moisture due to use of mulches has not only enhanced water use efficiency of mulberry plant but also resulted in the improved growth of mulberry plant and leaf yield.

The nitrogen content of mulberry leaf significantly increased due to influence of different mulches in both the seasons. The highest percentage of nitrogen content in mulberry was noticed in *Gliricidia* mulched plots (2.18%) and (2.08%) in both rainy and winter season. The lowest was recorded in control plots (1.70%) and (1.63%) in both the seasons. The increased nitrogen content of mulberry over first crop might be due to soil moisture and improvement of organic matter content of soil due to mulching. The increased the soil nutrient status indirectly helps in nitrification and mineral solubility and improve soil structure. These findings are in conformity with Giri and Singh (1985) [5] reported that straw mulch increased N uptake by 24 per cent in wheat over no mulch. Further, Das *et al*. (1990) [3] who reported that, green manuring with cowpea, horsegram and dry weed mulches increased the total leaf nitrogen by 17.9, 22.2 and 9.8 per cent, respectively over no mulch. Similarly, Nagesh (2002) [9] also reported that, nitrogen content of mulberry leaf was significantly higher when 100 percent recommended nutrients through green leaf manure (2.95%) over control. Further, Shashidhar (2006) [14] studied that, highest percentage of nitrogen content in mulberry was noticed in sunhemp mulched plots (2.04%) and lowest in no mulch (1.62%).

Phosphorus content of mulberry was differed significantly in both the rainy and winter seasons due to the influence of different mulches. The highest Phosphorus content in mulberry leaves was recorded in *Gliricidia* mulched plots (0.38%) and (0.32%) and lowest was recorded in control plots (0.2%) and (0.14%) during rainy and winter. Increased phosphorous, content in mulberry leaves may be due to utilization of conserved soil moisture and increase in the availability of native phosphorous, through the action of organic acids produced during the decomposition of organic matter. This study is in conformity with Robinson and Hosegood (1965) [12] who had noticed an increase in phosphorus content of Coffee leaf by 0.125 to 0.146 per cent by mulching. Similarly, Giri and Singh (1985) [5] reported that straw mulch increased P uptake by 28.6 per cent in wheat. Further, Shashidhar (2006) [14] who reported that, higher phosphorus content of mulberry leaf was exhibited in *Cassia sericea* mulch (0.38%) and it was followed by paddy straw (0.36%) and sunhemp (0.31%) respectively over other treatments and lowest was recorded in no mulch (0.22%).

Potassium content of mulberry leaves was also differed significantly due the influence of different mulches. Potassium content of mulberry leaves recorded highest in *Gliricidia* mulched plots (1.88%) and (1.76%) which is on par with Mulberry twigs mulched plots (1.82%) and (1.73 %) and lowest was recorded in control plots (1.49%) and (1.29%)

during both rainy and winter season. Further, there was an increase in potassium content in mulberry leaves where *Gliricidia* was used as a mulching material. This may be due to the fact that the plants might have utilized the conserved moisture in the soil and high organic matter content in the soil which is because of decomposition of *Gliricidia*. These results are in agreement with Nagesh (2002) who reported that 100 per cent recommended nutrients applied through green leaf manure significantly increased the phosphorous content of mulberry (2.24%) over control. Vos and Sumarani (1997) [15] also reported that more potassium content in hot pepper leaves by straw mulching. These results are in confirmity with results obtained by Raghothama (1979) [11] in Cardamom and Abd Elgowad (1978) [1] in maize. However, Shashidhar (2006) [14] reported that, the maximum potassium content of mulberry leaves was obtained in paddy straw mulch (1.96%), which was followed by sunhemp (1.84%) and enriched coir pith mulch (1.81%) over other treatments and control (1.61%).

Table 1: Influence of different types of mulches on growth and yield parameters of V_1 mulberry during rainy and winter seasons

Treatment	Plant height (cm)		Number of branches/plant		Number of leaves / plant		Leaf to shoot ratio		Single leaf area (cm^2)		Leaf yield /plant (g)	
	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter
Gliricidia mulch	195.87	184.83	24.19	19.70	201.27	176.50	15.97	14.22	195.18	189.61	384.76	354.34
Weed mulch	175.32	159.29	16.98	12.53	179.80	156.92	12.15	10.71	181.15	160.22	352.24	320.79
Forest litter mulch	185.08	179.71	19.15	18.44	191.22	171.81	14.30	13.47	190.20	188.06	366.43	340.30
Mulberry twigs mulch	192.87	175.06	23.00	16.62	200.69	169.35	15.92	13.10	195.11	182.63	380.78	334.76
Polythene mulch	182.69	168.02	17.63	14.48	186.39	164.75	12.76	11.75	184.44	168.58	352.26	324.37
Shade net mulch	188.06	170.09	21.46	15.81	193.45	167.80	15.03	12.18	194.04	178.18	378.27	328.15
Control	168.26	143.59	15.33	9.46	173.74	135.91	11.39	8.67	162.87	154.31	307.94	293.85
F-Test	*	*	*	*	*	*	*	*	*	*	*	*
SEm±	2.725	1.873	0.798	0.650	3.276	4.301	0.491	0.161	0.654	0.476	0.499	2.092
CD @ 5%	8.397	5.770	2.48	2.003	10.094	13.254	1.512	0.55	2.015	1.466	1.726	7.238

*Significant at 5%; DAM-Days after mulching

Table 2: Influence of different types of mulches on moisture content (%) and moisture retention capacity (%) of V_1 mulberry at 60 days after mulching during rainy and winter seasons

Treatment	Moisture content (%)		Moisture retention capacity (%)							
	Rainy	Winter	Rainy 3hr	Winter 3hr	Rainy 6hr	Winter 6hr	Rainy 12hr	Winter 12hr	Rainy 24hr	Winter 24hr
Gliricidia mulch	74.77	69.97	72.17	65.30	70.68	63.18	67.28	61.04	61.77	53.72
Weed mulch	72.48	63.67	69.76	62.44	68.68	60.18	65.65	58.78	58.10	51.07
Forest litter mulch	72.63	68.51	70.03	64.57	69.15	62.64	66.15	60.52	59.70	53.63
Mulberry twigs mulch	74.11	66.64	71.29	65.25	69.69	62.29	67.02	60.12	61.25	52.58
Polythene mulch	71.69	65.23	69.60	63.05	68.22	61.27	65.11	59.44	57.82	51.43
Shade net mulch	72.64	65.76	70.63	63.71	69.03	61.64	66.79	59.51	60.33	52.37
Control	70.99	61.20	68.64	60.36	67.21	58.81	64.23	57.53	56.50	50.06
F-Test	*	*	*	*	*	*	*	*	*	*
SEm±	0.360	0.083	0.120	0.033	0.042	0.101	0.053	0.035	0.147	0.197
CD @ 5%	1.109	0.256	0.417	0.113	0.146	0.349	0.185	0.120	0.509	0.682

*Significant at 5%; DAM-Days after mulching

Table 3: Influence of different types of mulches on nutrient content (%) of V_1 mulberry at 60 days after mulching during rainy and winter seasons

Treatment	Rainy			Winter		
	N%	P%	K%	N%	P%	K%
Gliricidia mulch	2.18	0.38	1.88	2.08	0.32	1.76
Weed mulch	1.76	0.20	1.59	1.75	0.15	1.47
Forest litter mulch	1.84	0.22	1.72	2.03	0.20	1.75
Mulberry twigs mulch	2.07	0.29	1.82	1.93	0.20	1.73
Polythene mulch	1.80	0.22	1.66	1.85	0.16	1.68
Shade net mulch	1.98	0.25	1.77	1.83	0.20	1.73
Control	1.7	0.2	1.49	1.63	0.14	1.29
F-Test	*	*	*	*	*	*
SEm±	0.024	0.006	0.014	0.013	0.013	0.018
CD @ 5%	0.073	0.018	0.042	0.046	0.046	0.063

*Significant at 5%; DAM-Days after mulching

4. Conclusion

All the growth and yield parameters of mulberry were significantly superior in *Gliricidia* mulched plots compared to other mulches tested during rainy and winter seasons. The leaf moisture content, moisture retention capacity of leaves and the nutrient content of the leaves are also superior in the mulberry plots mulched with *Gliricidia*.

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