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Influence of integrated weed management practices on soil properties, nutrient status and biochemical composition of mulberry

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Abstract

A field experiment was conducted during 2025 to evaluate the effect of integrated weed management practices on soil properties, nutrient status and biochemical quality of mulberry. The experiment was laid out in a Randomized Complete Block Design with fourteen treatments and three replications. Among all the treatments, T₉ (hand weeding immediately after pruning followed by intercropping with fodder cowpea) recorded higher post-harvest soil available nitrogen (253.52 kg ha⁻¹), phosphorus (50.24 kg ha⁻¹) and potassium (195.33 kg ha⁻¹), leaf nitrogen (2.88%), phosphorus (0.37%) and potassium (2.03%), chlorophyll-a (1.32 mg g⁻¹), chlorophyll-b (1.13 mg g⁻¹), total chlorophyll (2.45 mg g⁻¹), crude protein (17.91%) and crude fibre (10.52%). Higher leaf moisture (71.94%) and carbohydrate content (17.85%) were recorded in T₃ (hand weeding immediately after pruning followed by plastic mulching within a week). Among the herbicide-based treatments, T₈ (paraquat dichloride followed by plastic mulching) performed relatively better than the other chemical treatments. The study indicated that hand weeding immediately after pruning followed by fodder cowpea intercropping or plastic mulching can be considered as effective and sustainable weed management practices for improving soil fertility and biochemical quality of mulberry leaves.

Keywords: Mulberry, weed management, intercropping, plastic mulching, soil nutrients, leaf quality

Introduction

Mulberry (*Morus alba* L.) is the sole food plant of the silkworm, *Bombyx mori* L., and the productivity of sericulture largely depends on the quantity and quality of mulberry leaves. The nutritional and biochemical composition of mulberry leaves has a direct influence on silkworm growth, cocoon yield and silk quality. Therefore, maintenance of healthy mulberry gardens with good soil fertility and efficient crop management is essential for sustainable cocoon production.

Among the various constraints affecting mulberry cultivation, weed infestation is one of the major problem responsible for reducing leaf yield and deteriorating leaf quality. Weeds compete with mulberry for moisture, nutrients, light and space and also interfere with the uptake and utilization of nutrients by the crop. This competition leads to poor growth and lower quality leaves, which in turn affect silkworm performance. The adverse effect of crop-weed competition on mulberry growth and productivity has been reported by Krishna *et al.* (2012) [14] and Bali and Pandit (2014) [2].

Hand weeding is one of the most effective methods of weed control in mulberry, but it is labour intensive and costly. Hence, integrated weed management practices involving hand weeding, herbicides, mulching and intercropping are considered more practical and sustainable. Mulching suppresses weed emergence, conserves soil moisture and creates favourable conditions for nutrient uptake, while legume intercropping improves soil fertility through nitrogen fixation and recycling of nutrients. Earlier researchers have reported the beneficial effects of integrated weed management in mulberry on weed suppression, nutrient status and crop growth (Ghosh *et al.*, 2010; Setua *et al.*, 2009) [9, 21].

Leaf nutrient composition and biochemical constituents such as chlorophyll, moisture, carbohydrate, crude protein and crude fibre are important quality parameters in mulberry.

These parameters are influenced by soil fertility, moisture availability and weed management practices. Improved nutrient uptake and effective weed suppression generally result in better leaf quality, which is essential for successful silkworm rearing. Positive effects of mulching and intercropping on mulberry leaf quality have also been reported by Rajegowda *et al.*, (2020) ^[19] and Islam *et al.*, (2023) ^[11]. Therefore, the present investigation was undertaken to study the effect of integrated weed management practices on soil properties, nutrient status and biochemical quality of mulberry.

Material and Methods

The experiment was conducted during 2025 in a well-established V1 mulberry garden at the Department of Sericulture, College of Agriculture, Gandhi Krishi Vignana Kendra, Bengaluru. The experimental site is geographically situated in the Eastern Dry Zone (Zone-V) of Karnataka at 13°05' North latitude and 77°34' East longitude, with an altitude of 930 m above mean sea level.

The experiment was established with fourteen treatment combinations, viz., T₁-unweeded check, T₂-hand weeding twice (one immediately after pruning and second on 25 DAP), T₃-hand weeding immediately after pruning and mulching with plastic within a week, T₄-glyphosate @ 6 ml L⁻¹ at 2 to 4 DAP + wheel hoe weeder at 40th DAP, T₅-early post-emergence application of propaquizafop 10% EC @ 100 g a.i ha⁻¹ at 2 to 4 leaf stage of weed + wheel hoe

weeder at 40th DAP, T₆-early post-emergence application of propaquizafop 10% EC @ 100 g a.i ha⁻¹ at 2 to 4 leaf stage of weed + mulching with plastic at 15 days after application, T₇-post-emergence application of paraquat dichloride 24% SL @ 1.25 kg a.i ha⁻¹ at 2 to 4 leaf stage of weed + wheel hoe weeder at 40th DAP, T₈-post-emergence application of paraquat dichloride 24% SL @ 1.25 kg a.i ha⁻¹ at 2 to 4 leaf stage of weed + mulching with plastic at 15 days after application, T₉-hand weeding immediately after pruning and intercropping with fodder cowpea, T₁₀-mechanical weeding by using power tiller at 20 and 40 DAP, T₁₁-post-emergence application of indaziflam 20 + glyphosate IPA 540 SC @ 1050 g a.i ha⁻¹ at 2 to 4 DAP + wheel hoe weeder at 40th DAP, T₁₂-post-emergence application of indaziflam 20 + glyphosate IPA 540 SC @ 1050 g a.i ha⁻¹ at 2 to 4 DAP + mulching with plastic at 15 days after application, T₁₃-quizalofop-p-butyl @ 1.5 ml L⁻¹ + imazethapyr @ 1.5 ml L⁻¹ at 2 to 4 DAP + wheel hoe weeder at 40th DAP and T₁₄-quizalofop-p-butyl @ 1.5 ml L⁻¹ + imazethapyr @ 1.5 ml L⁻¹ at 2 to 4 DAP + mulching with plastic at 15 DAP. These treatments were laid out in a Randomized Complete Block Design with three replications.

The quantity of herbicide and water required for spraying was computed on the basis of gross plot size. Soil samples were collected before and after the crop and analyzed for soil pH, electrical conductivity, organic carbon and available nitrogen, phosphorus and potassium by following standard procedures.

Table 1: Standard methods adopted for soil analysis

Sl. No.	Parameter	Method	Procedure outlined by
1	Soil reaction (pH)	Potentiometric method	Jackson, 1973 ^[12]
2	EC (dS m ⁻¹)	Conductivity Bridge	Jackson, 1973 ^[12]
3	Organic Carbon (%)	Wet oxidation Method	Walkley and Black, 1934 ^[30]
4	Available N (kg ha ⁻¹)	Alkaline KMnO ₄ method	Subbiah and Asija, 1956 ^[27]
5	Available P ₂ O ₅ (kg ha ⁻¹)	Bray's/Olsen's method	Jackson, 1973 ^[12]
6	Available K ₂ O (kg ha ⁻¹)	Flame photometric method	Jackson, 1973 ^[12]

Mulberry leaf samples were collected at 60 DAP and analyzed for nutrient composition and biochemical quality parameters such as chlorophyll-a, chlorophyll-b, total

chlorophyll, moisture, carbohydrate, crude protein and crude fibre by following standard procedures.

Table 2: Standard methods adopted for plant analysis

Sl. No.	Parameter	Plant analysis Procedure	Procedure outlined by
1	Nitrogen (%)	Kjeldahl's digestion distillation method	Piper (1966) ^[18]
2	Phosphorus (%)	Di-acid digestion and Vanadomolybdate method	Piper (1966) ^[18]
3	Potassium (%)	Flame photometric method	Jackson (1973) ^[12]
4	Total Chlorophyll, Chlorophyll a, b (mg g ⁻¹)	Arnon method	Hiscox and Israelstam, 1979 ^[10]
5	Leaf moisture content (%)	Gravimetric method	Turner, 1981 ^[29]
6	Total carbohydrate (%)	Anthrone reagent method	Dubois <i>et al.</i> , 1956 ^[7]
7	Crude protein (mg g ⁻¹)	Kjeldahl's method	Kjeldahl 1883
8	Crude fibre (%)	Gravimetric method	Mertens, 2002 ^[15]

The data on Soil and leaf quality parameters at 60 DAP of mulberry crop were recorded and mean value was worked out. The experimental data collected on soil and plant quality parameters were subjected to Fisher's method of Analysis of Variance (ANOVA) as outlined by Sundararaj *et al.* (1972).

Results and Discussion

The results and discussion on the effect of integrated weed management practices on soil nutrient status and biochemical compositions of mulberry leaf are revealed as follows:

Table 3: Soil properties in post-harvest soil as influenced by weed management methods

Treatment	Soil pH (1:2.5)	Electrical conductivity (dS m ⁻¹)	Organic carbon (%)
T ₁	6.65	0.18	0.49
T ₂	6.66	0.20	0.50
T ₃	6.72	0.21	0.53
T ₄	6.66	0.19	0.50
T ₅	6.64	0.18	0.48
T ₆	6.65	0.18	0.49
T ₇	6.68	0.19	0.50
T ₈	6.69	0.20	0.51
T ₉	6.71	0.21	0.52
T ₁₀	6.63	0.18	0.48
T ₁₁	6.69	0.19	0.51
T ₁₂	6.70	0.20	0.51
T ₁₃	6.65	0.18	0.49
T ₁₄	6.66	0.19	0.50
F test	NS	NS	NS
S. Em±	0.03	0.01	0.01
CD _{0.05}	-	-	-
CV	1.13	8.72	2.73

Note: NS-non-significant

Soil pH, electrical conductivity and organic carbon

Soil pH, electrical conductivity and organic carbon content did not differ significantly among the different weed management practices. Soil pH ranged from 6.63 to 6.72, electrical conductivity from 0.18 to 0.21 dS m⁻¹ and organic carbon from 0.48 to 0.53 percent. The non-significant variation in these parameters indicates that the weed management practices did not exert any adverse effect on the basic chemical properties of the soil. The findings are in close agreement with the observations of Ghosh *et al.* (2010)^[9] and Setua *et al.* (2009)^[21], who also reported that integrated weed management practices improved crop performance without causing marked changes in soil reaction and electrical conductivity.

Table 4: Major nutrient status in post-harvest soil as influenced by weed management methods

Treatment	Available nitrogen (kg ha ⁻¹)	Available phosphorus (kg ha ⁻¹)	Available potassium (kg ha ⁻¹)
T ₁	216.35	39.66	171.95
T ₂	247.41	47.33	190.05
T ₃	250.34	48.46	192.53
T ₄	233.03	44.11	182.24
T ₅	221.19	41.02	175.06
T ₆	226.81	43.03	179.21
T ₇	235.89	44.99	183.87
T ₈	244.62	46.44	188.74
T ₉	253.52	50.24	195.33
T ₁₀	218.19	40.35	173.51
T ₁₁	238.83	45.60	185.31
T ₁₂	241.71	46.09	187.36
T ₁₃	223.98	42.19	177.28
T ₁₄	229.74	43.47	180.71
F test	*	*	*
S. Em±	0.50	0.17	0.18
CD _{0.05}	1.47	0.50	0.54
CV	0.37	0.68	0.17

Note: *significant @ 5%

Primary nutrient status in post-harvest soil

The available nitrogen, phosphorus and potassium content of post-harvest soil differed significantly among the weed management practices. The highest available nitrogen (253.52 kg ha⁻¹), phosphorus (50.24 kg ha⁻¹) and potassium (195.33 kg ha⁻¹) were recorded in T₉, followed by T₃, which registered 250.34 kg ha⁻¹ nitrogen, 48.46 kg ha⁻¹ phosphorus and 192.53 kg ha⁻¹ potassium. Treatment T₂ also maintained comparatively higher nutrient availability than most of the remaining treatments. Among the herbicide-based treatments, T₈ recorded relatively higher available nutrient status than the other chemical treatments, whereas the lowest nutrient availability was recorded in T₁.

The higher nutrient availability observed in T₉ may be attributed to the beneficial effect of fodder cowpea intercropping, since legumes are known to contribute to biological nitrogen fixation and improved nutrient recycling, as noted by Muniyappa and Shivakumar (1994)^[25, 26]. Likewise, the improved nutrient status under T₃ might be due to the role of mulching in conserving soil moisture, reducing weed competition and minimizing nutrient losses, which is in accordance with the findings of Setua *et al.* (2009)^[21]. Similar enhancement in soil nutrient availability under integrated mulberry management practices was also reported by Rajegowda *et al.* (2020)^[19] and Islam *et al.* (2023)^[11].

Table 5: Major nutrient content in mulberry leaves as influenced by weed management methods

Treatment	Nitrogen (%)	Phosphorus (%)	Potassium (%)
T ₁	2.20	0.25	1.08
T ₂	2.74	0.35	1.86
T ₃	2.83	0.36	1.95
T ₄	2.57	0.31	1.72
T ₅	2.35	0.27	1.34
T ₆	2.47	0.29	1.51
T ₇	2.63	0.33	1.77
T ₈	2.75	0.35	1.91
T ₉	2.88	0.37	2.03
T ₁₀	2.28	0.25	1.18
T ₁₁	2.67	0.34	1.81
T ₁₂	2.74	0.35	1.89
T ₁₃	2.44	0.29	1.42
T ₁₄	2.53	0.31	1.61
F test	*	*	*
S. Em±	0.07	0.01	0.01
CD _{0.05}	0.21	0.02	0.03
CV	4.62	4.03	1.36

Note: *significant @ 5%

Primary nutrient composition of mulberry leaves

The primary nutrient composition of mulberry leaves was significantly influenced by the different weed management practices. Leaf nitrogen, phosphorus and potassium content ranged from 2.20 to 2.88 percent, 0.25 to 0.37 percent and 1.08 to 2.03 percent, respectively. The highest leaf nitrogen (2.88%), phosphorus (0.37%) and potassium (2.03%) were recorded in T₉, followed by T₃ with 2.83 percent nitrogen, 0.36 percent phosphorus and 1.95 percent potassium. Among the herbicide-based treatments, T₈ recorded comparatively better nutrient composition than the other chemical treatments, whereas T₁ recorded the lowest values. The higher nutrient content of leaves in T₉ and T₃ may be due to better nutrient availability in the soil, reduced weed competition and enhanced uptake of nutrients by mulberry

plants. Under such favourable soil conditions, intercropping and mulching might have improved root activity and nutrient translocation to the leaves, as also observed by Ghosh *et al.* (2010)^[9] similarly reported that improved crop management practices enhanced nutrient uptake and leaf quality. The present findings are also supported by the reports of Setua *et al.* (2006), who documented higher nutrient accumulation in mulberry leaves under improved soil and crop management conditions.

Table 4: Effect of weed management methods on chlorophyll and leaf moisture content of mulberry leaf

Treatment	Total Chlorophyll (mg g ⁻¹)	Chlorophyll-a (mg g ⁻¹)	Chlorophyll-b (mg g ⁻¹)	Leaf moisture (%)
T ₁	1.68	0.93	0.75	69.11
T ₂	2.25	1.19	1.06	71.10
T ₃	2.41	1.30	1.11	71.94
T ₄	2.03	1.06	0.96	70.13
T ₅	1.81	0.98	0.83	69.46
T ₆	1.92	1.02	0.90	70.34
T ₇	2.08	1.11	0.97	70.53
T ₈	2.27	1.23	1.04	71.04
T ₉	2.45	1.32	1.13	71.60
T ₁₀	1.74	0.95	0.79	69.81
T ₁₁	2.13	1.14	1.00	70.74
T ₁₂	2.21	1.17	1.04	71.04
T ₁₃	1.87	1.00	0.87	70.00
T ₁₄	1.96	1.05	0.91	70.12
F test	*	*	*	*
S. Em±	0.07	0.02	0.04	0.23
CD _{0.05}	0.24	0.06	0.09	0.71
CV	5.34	4.16	5.18	0.49

Note: *significant @ 5%

Total chlorophyll, chlorophyll (a, b) and leaf moisture

Total chlorophyll, chlorophyll-a, chlorophyll-b and leaf moisture content of mulberry leaves differed significantly among the weed management practices. The highest chlorophyll-a (1.32 mg g⁻¹), chlorophyll-b (1.13 mg g⁻¹) and total chlorophyll (2.45 mg g⁻¹) contents were recorded in T₉, followed by T₃ with 1.30, 1.11 and 2.41 mg g⁻¹, respectively. Among the herbicide-based treatments, T₈ recorded comparatively higher chlorophyll-a (1.23 mg g⁻¹), chlorophyll-b (1.04 mg g⁻¹) and total chlorophyll (2.27 mg g⁻¹), followed by T₁₂. The lowest chlorophyll content was observed in T₁, which recorded 0.93 mg g⁻¹ chlorophyll-a, 0.75 mg g⁻¹ chlorophyll-b and 1.68 mg g⁻¹ total chlorophyll. Leaf moisture content was also significantly influenced by the weed management practices and ranged from 69.11 to 71.94 percent. The highest leaf moisture content was recorded in T₃ (71.94%), followed by T₉ (71.60%) and T₂ (71.10%). Among the herbicide-based treatments, T₈ and T₁₂ each recorded 71.04 percent leaf moisture, which was higher than most of the other chemical treatments. The lowest leaf moisture content was recorded in T₁ (69.11%).

The higher chlorophyll and leaf moisture content observed in T₉ and T₃ may be attributed to effective weed suppression, better soil moisture conservation and improved nutrient availability under intercropping and mulching. Better physiological efficiency of leaves under such favourable conditions has also been emphasized by Mohler and Callaway (1992). Similarly, Arun Kumar (2013) reported that improved field management practices enhanced chlorophyll synthesis and leaf succulence in

mulberry. The present trend also corroborates the findings of Islam *et al.* (2023)^[11], who observed improved chlorophyll content and leaf moisture under better nutrient and moisture management.

Table 4: Effect of weed management methods on carbohydrate, crude protein and crude fibre content in mulberry leaf

Treatment	Carbohydrate (%)	Crude protein (%)	Crude fibre (%)
T ₁	12.00	13.71	7.69
T ₂	17.00	17.03	10.07
T ₃	17.85	17.64	10.31
T ₄	14.70	15.98	8.55
T ₅	13.00	14.62	7.80
T ₆	15.15	15.38	8.81
T ₇	15.45	16.37	9.07
T ₈	16.60	17.13	9.82
T ₉	17.45	17.91	10.52
T ₁₀	13.60	14.22	7.97
T ₁₁	15.90	16.64	9.32
T ₁₂	16.25	17.04	9.55
T ₁₃	13.95	15.16	8.14
T ₁₄	14.30	15.75	8.33
F test	*	*	*
S. Em±	0.11	0.11	0.12
CD _{0.05}	0.35	0.37	0.37
CV	1.18	1.12	2.18

Note: *significant @ 5%

Carbohydrate, crude protein and crude fibre

The carbohydrate, crude protein and crude fibre content of mulberry leaves differed significantly among the weed management practices. The highest carbohydrate content was recorded in T₃, whereas crude protein and crude fibre contents were highest in T₉, followed closely by T₃. Among the herbicide-based treatments, T₈ recorded comparatively better values than the other chemical treatments. The lowest values for these biochemical constituents were observed in T₁.

The improvement in carbohydrate, crude protein and crude fibre content under T₉ and T₃ may be attributed to better nutrient uptake, favourable soil moisture conditions and reduced weed competition, which together might have enhanced photosynthetic activity and protein synthesis. Setua *et al.* (2009)^[21] also observed that improved field management practices increased the biochemical quality of mulberry leaves. In the same line, Arun Kumar (2013) reported better accumulation of quality constituents in mulberry under improved agronomic conditions. Similar results were further documented by Rajegowda *et al.* (2020)^[19] and Islam *et al.* (2023)^[11], who noted enhanced biochemical parameters under integrated crop management practices.

Conclusion

Integrated weed management practices significantly influenced soil nutrient availability, leaf nutrient composition and the biochemical quality of mulberry leaves, whereas soil pH, electrical conductivity and organic carbon remained unaffected. Among the different treatments, T₉ (hand weeding immediately after pruning followed by intercropping with fodder cowpea) recorded superior post-harvest soil nutrient status and improved mulberry leaf quality in terms of nutrient composition, chlorophyll content, leaf moisture and biochemical constituents.

Treatment T₃ (hand weeding immediately after pruning followed by plastic mulching within a week) also recorded comparable results and was particularly effective in improving leaf moisture content and suppressing weed competition. Among the herbicide-based treatments, T₈ (paraquat dichloride followed by plastic mulching) performed relatively better than the other chemical treatments. Therefore, integrated weed management practices involving hand weeding combined with fodder cowpea intercropping or plastic mulching may be considered suitable and sustainable approaches for improving soil fertility and leaf quality in mulberry.

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