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Pramod K

Department of Sericulture, College
of Agriculture, UAS, GKVK,
Bengaluru, Karnataka, India

KS Vinoda

Department of sericulture, College
of Agriculture, UAS, GKVK,
Bengaluru, Karnataka, India

KG Banuprakash

Department of sericulture, College
of Agriculture, UAS, GKVK,
Bengaluru, Karnataka, India

KN Geetha

Head, AICRP-Weed management
UAS, GKVK, Bengaluru,
Karnataka, India

K Ranganatha

Department of sericulture, College
of Agriculture, UAS, GKVK,
Bengaluru, Karnataka, India

Varun MS

Department of sericulture, College
of Agriculture, UAS, GKVK,
Bengaluru, Karnataka, India

Corresponding Author:

Pramod K

Department of Sericulture, College
of Agriculture, UAS, GKVK,
Bengaluru, Karnataka, India

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Effect of integrated weed management practices on growth and yield of mulberry

Pramod K, KS Vinoda, KG Banuprakash, KN Geetha, K Ranganatha and Varun MS

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Abstract

A field experiment was conducted during 2025 to evaluate the effect of integrated weed management practices on weed parameters, growth and yield of mulberry. The experiment was laid out in a Randomized Complete Block Design with fourteen treatments and three replications. Among the treatments, T₃ (hand weeding immediately after pruning followed by plastic mulching within a week) recorded the lowest total weed density (10.17, 8.17 and 15.00 no. m⁻²) and weed dry weight (2.70, 3.24 and 7.09 g m⁻²) at 20, 40 and 60 days after pruning, respectively. The same treatment also recorded the highest shoot length (139.59 cm), number of shoots per plant (21.73), number of leaves per shoot (28.77), leaf area (140.80 cm²) at 45 days after pruning, leaf yield per plant (3.40 kg) and leaf yield per hectare (3766 kg ha⁻¹ crop⁻¹) at 60 days after pruning. This was followed by T₉ (hand weeding immediately after pruning and intercropping with fodder cowpea). Among the herbicide-based treatments, T₈ (paraquat dichloride 24% SL @ 1.25 kg a.i. ha⁻¹ followed by plastic mulching) was found to be superior in reducing weed growth and improving mulberry performance. The study indicated that integration of hand weeding with plastic mulching or fodder cowpea intercropping was more effective for weed suppression and yield improvement in mulberry.

Keywords: Mulberry, integrated weed management, weed density, weed dry weight, plastic mulching, cowpea intercropping, growth, yield

Introduction

Mulberry (*Morus alba* L.) is a perennial and deep-rooted foliage crop cultivated primarily for leaf production, which serves as the exclusive food source for the silkworm, *Bombyx mori* L. It has been documented that nearly 70 per cent of silk proteins are directly derived from mulberry leaves; hence, sustained production of good quality leaves in sufficient quantity is essential for successful cocoon production and raw silk output. Therefore, efficient crop management practices that ensure higher leaf yield and quality are prerequisites for profitable sericulture (Datta, 2000) [7].

Mulberry is grown intensively under irrigated conditions and is maintained for about 15 to 20 years with repeated pruning and frequent nutrient application. These agronomic conditions, along with wider spacing and regular irrigation, create a favourable environment for luxuriant weed growth. Weeds compete with mulberry for essential resources such as moisture, nutrients, light and space, thereby suppressing crop growth and reducing leaf yield and quality. In addition, weeds may also harbour pests and pathogens and indirectly affect the health of the crop and the silkworm ecosystem (Aldrich and Kremer, 1997; Shanmugam *et al.*, 2012) [1, 21].

A wide range of weed species have been reported in mulberry gardens across India, including grasses, broad-leaved weeds and sedges. Among them, *Parthenium hysterophorus* is considered one of the most obnoxious broad-leaved weeds, whereas *Cyperus rotundus* and *Cynodon dactylon* are important perennial monocot weeds causing serious competition in irrigated mulberry fields (Khare *et al.*, 2023; Sikdar, 1979; Dandin and Giridhar, 2014) [11, 22, 5]. Weed infestation during the early crop growth period is particularly harmful. In mulberry, the initial 30 to 45 days after pruning is considered the critical period of crop-weed competition, during which unchecked weed growth can substantially reduce leaf yield and quality (Setua *et al.*, 2009; Krishna *et al.*, 2012; Shanmugam *et al.*, 2012) [19, 12, 21].

Conventionally, weeds in mulberry are managed through hand weeding and mechanical operations. However, these methods are labour intensive, costly and often difficult to perform at the critical stage because of labour scarcity. On the other hand, sole dependence on herbicides may provide only temporary control and may raise concerns regarding environmental pollution, residual toxicity and possible adverse effects on silkworms. Therefore, integrated weed management involving a combination of cultural, mechanical and chemical methods appears to be a sustainable and effective approach for controlling weeds in mulberry. Practices such as mulching, intercropping with legumes and judicious herbicide use may suppress weed emergence, improve soil moisture conservation and enhance crop growth (Ghosh *et al.*, 2010; Setua *et al.*, 2009; Sakthivel, 2019) [9, 19, 18]. Hence, the present study was undertaken to evaluate the effect of integrated weed management practices on weed density, weed dry weight, growth and yield of mulberry.

Materials 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 Vigyana 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 consisted of fourteen treatment combinations viz.,

T₁ - Un weeded 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 2–4 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 (1.65% w/w + 44.63% w/w) @ 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 (1.65% w/w + 44.63% w/w) @ 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

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 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. The weedy plots remained infested with native weed population throughout the crop period. Weed parameters such as weed density and weed dry weight were recorded at 20, 40 and 60 days after pruning. Weed density was recorded by placing a quadrat of 50 cm × 50 cm at two randomly selected spots in each plot and counting the number of weeds species-wise. The weed species were categorized into grasses and broad-leaved weeds and the average weed density was expressed as number m⁻². Weed dry weight was recorded by collecting weeds from the sampled quadrat area, drying them in a hot air oven at 70 °C until constant weight and expressing the data as g m⁻².

Growth and yield parameters such as maximum shoot length, number of shoots per plant, number of leaves per shoot, leaf area, leaf yield per plant and leaf yield per hectare were recorded at 60 DAP. Observations were recorded on randomly selected plants from each net plot and the mean value was worked out. The experimental data collected on weed parameters, growth and yield components were subjected to Fisher's method of analysis of variance (ANOVA) as outlined by Sundararaj *et al.* (1972) [24].

Results and Discussion

The results and discussion on the effect of integrated weed management practices on weed parameters, growth and yield of mulberry are revealed as follows:

Weed density (No. m⁻²)

Weed density in mulberry was significantly influenced by different integrated weed management practices at 20, 40 and 60 DAP. Among all the treatments, T₃ (hand weeding immediately after pruning and mulching with plastic within a week) recorded the lowest total weed density (10.17, 8.17 and 15.00 no. m⁻² at 20, 40 and 60 DAP, respectively), followed by T₉ (hand weeding immediately after pruning and intercropping with fodder cowpea), which recorded 12.34, 13.34 and 18.00 no. m⁻², respectively. Among the herbicide-based treatments, T₈ (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) recorded comparatively lower weed density (22.50, 17.33 and 28.67 no. m⁻², respectively), whereas T₅ (propaquizafop 10% EC + wheel hoe weeder) recorded the highest weed density among the treated plots (56.33, 62.67 and 61.67 no. m⁻², respectively). The maximum weed density was observed in the unweeded control, T₁ (69.17, 104.6 and 140.83 no. m⁻², respectively).

The lower weed density recorded in T₃ may be attributed to the combined effect of immediate removal of emerged weeds by hand weeding and physical suppression of subsequent weed emergence by plastic mulch. Mulching acts as a barrier to light penetration and thereby prevents weed germination and establishment. Similarly, intercropping with fodder cowpea in T₉ provided biological suppression by covering the soil surface quickly and reducing the space, light and nutrients available for weed growth. The better performance of T₈ among herbicide-based treatments may be due to the quick contact action of paraquat on emerged weeds, followed by continued suppression through plastic mulching. These results are in conformity with the findings of Shanmugam *et al.* (2009) [20] and Sakthivel (2019) [18], who reported effective weed suppression in mulberry under integrated use of herbicides and mulching.

Weed dry weight (g m⁻²)

Weed dry weight was also significantly influenced by integrated weed management practices at 20, 40 and 60 DAP. Among the treatments, T₃ recorded the lowest total weed dry weight (2.70, 3.24 and 7.09 g m⁻² at 20, 40 and 60 DAP, respectively), followed by T₉, which recorded 2.96, 3.78 and 7.71 g m⁻², respectively. Among herbicide-based treatments, T₈ recorded lower weed dry weight (3.70, 5.09 and 9.28 g m⁻², respectively), whereas the highest weed dry weight among the treated plots was observed in T₅ (9.40, 10.08 and 13.26 g m⁻², respectively). The maximum weed dry weight was recorded in the unweeded control T₁ (16.89, 23.79 and 36.24 g m⁻², respectively).

The lower weed dry matter accumulation in T₃ and T₉ clearly indicates the effectiveness of sustained weed suppression

throughout the crop growth period. Plastic mulch restricted weed emergence and growth for a longer duration, while cowpea intercropping acted as a live mulch, reducing weed biomass through shading and competition. The better performance of T₈ may be attributed to the rapid desiccation of weeds by paraquat, followed by reduced emergence under mulching. In contrast, herbicide treatments followed only by wheel hoeing failed to provide prolonged suppression, which might have allowed weed regrowth and resulted in higher dry matter accumulation. Similar observations were reported by Ghosh *et al.* (2010) [9] and Shanmugam *et al.* (2012) [21], who emphasized that integrated approaches are more effective than single weed-control methods in perennial crops like mulberry.

Table 1: Effect of weed management methods on Weed density (No./m²) in mulberry at 20, 40 and 60 DAP

Treatment	20 DAP			40 DAP			60 DAP		
	Grasses	BLW	Total	Grasses	BLW	Total	Grasses	BLW	Total
T ₁	36.84(6.11)	32.34(5.73)	69.17(8.34)	56.34 (7.54)	48.34 (6.99)	104.6(10.26)	72.84 (8.57)	68.00 (7.62)	140.83 (11.89)
T ₂	8.33 (2.97)	7.67 (2.13)	16.00(4.06)	7.00 (2.73)	7.00 (2.73)	14.00 (3.80)	16.67 (4.12)	16.34 (3.42)	33.00 (5.77)
T ₃	5.50 (2.44)	4.67 (2.27)	10.17(3.27)	4.50 (2.23)	3.67 (2.00)	8.17 (2.92)	8.00 (2.89)	7.00 (2.33)	15.00 (3.93)
T ₄	14.67(3.89)	23.00(4.84)	37.67(6.18)	18.67 (4.37)	25.67 (5.12)	44.34 (6.70)	19.67 (4.49)	15.67 (4.58)	36.33 (6.07)
T ₅	27.34(5.27)	29.00(5.43)	56.33(7.54)	31.34 (5.64)	31.34 (5.64)	62.67 (7.95)	28.00 (5.34)	33.67 (5.75)	61.67(7.88)
T ₆	24.00(4.94)	30.00(5.52)	54.00(7.38)	19.67 (4.49)	26.67 (5.21)	46.34 (6.84)	23.34 (4.88)	27.34 (5.28)	49.67 (7.09)
T ₇	14.17(3.83)	19.50(4.47)	33.67(5.85)	17.00 (4.18)	21.00 (4.63)	38.00 (6.20)	20.33 (4.56)	18.33 (4.48)	38.67 (6.25)
T ₈	11.17(3.41)	11.34(3.44)	22.50(4.80)	8.67 (3.02)	8.67 (3.03)	17.33(4.22)	15.00 (3.93)	13.67 (3.26)	28.67 (5.39)
T ₉	6.50 (2.64)	5.84 (2.52)	12.34(3.58)	7.00 (2.72)	6.33 (2.60)	13.34 (3.70)	9.67 (3.18)	8.33 (2.76)	18.00 (4.29)
T ₁₀	34.33(5.90)	31.34(5.64)	65.67(8.13)	17.34 (4.19)	13.67 (3.76)	31.00 (5.60)	18.67 (4.36)	16.67 (3.81)	35.33 (5.98)
T ₁₁	12.67(3.62)	16.84(4.16)	29.50(5.48)	10.33 (3.29)	11.00 (3.38)	21.33(4.67)	14.00 (3.80)	11.67 (3.33)	25.67 (5.11)
T ₁₂	11.34(3.44)	12.00(3.54)	23.34(4.88)	9.67 (3.18)	9.34 (3.12)	19.00(4.41)	14.17 (3.98)	13.00 (3.17)	28.67 (5.36)
T ₁₃	22.00(4.74)	28.67(5.40)	50.67(7.15)	30.67 (5.58)	31.00 (5.61)	61.67 (7.88)	23.67 (4.91)	31.67 (5.55)	55.33 (7.46)
T ₁₄	16.50(4.12)	25.17(5.07)	41.67(6.51)	14.33 (3.84)	17.34 (4.22)	31.67 (5.67)	23.00 (4.85)	28.33 (4.80)	51.33 (7.20)
F test	*	*	*	*	*	*	*	*	*
S. Em±	0.12	0.13	0.16	0.15	0.14	0.13	0.16	0.14	0.15
CD _{0.05}	0.34	0.38	0.45	0.39	0.40	0.37	0.45	0.40	0.41
CV	5.12	6.31	4.36	5.56	5.87	4.21	6.42	4.94	4.62

Note: *Significant @ 5%; weeds belonging to sedges were not found; BLW- Broad leaf weeds

Table 2: Effect of weed management methods on Weed dry weight (g/m²) in mulberry at 20, 40 and 60 DAP

Treatment	20 DAP			40 DAP			60 DAP		
	Grasses	BLW	Total	Grasses	BLW	Total	Grasses	BLW	Total
T ₁	6.00 (2.55)	10.43 (3.30)	16.89 (4.17)	7.93 (2.91)	15.86 (4.05)	23.79 (4.93)	13.00(3.71)	23.24(4.96)	36.24 (6.14)
T ₂	1.09 (1.26)	1.98 (1.57)	3.04 (1.87)	1.70 (1.50)	1.98 (1.64)	3.99 (2.08)	5.05 (2.37)	5.13 (2.32)	10.18 (3.34)
T ₃	0.96 (1.21)	1.81 (1.52)	2.70 (1.78)	1.48 (1.45)	1.61 (1.50)	3.24 (1.95)	3.51 (2.02)	3.59 (2.12)	7.09 (2.55)
T ₄	1.92 (1.55)	4.26 (2.18)	6.36 (2.61)	3.27 (1.96)	4.41 (2.19)	7.89 (2.89)	4.83 (2.27)	6.55 (2.67)	11.37 (3.46)
T ₅	3.56 (2.01)	5.64 (2.48)	9.40 (3.15)	4.24 (2.18)	5.57 (2.45)	10.08 (3.25)	5.92 (2.53)	7.35 (2.77)	13.26 (3.64)
T ₆	3.15 (1.93)	4.98 (2.34)	8.28 (2.96)	2.88 (1.95)	4.61 (2.29)	8.05 (2.89)	4.74 (2.14)	6.35 (2.59)	11.09 (3.38)
T ₇	1.85 (1.53)	3.65 (2.03)	5.58 (2.47)	2.95 (1.86)	4.24 (2.15)	7.25 (2.74)	4.65 (2.27)	6.39 (2.59)	11.14 (3.32)
T ₈	1.48 (1.40)	2.11 (1.62)	3.70 (2.05)	2.34 (1.90)	2.59 (1.97)	5.09 (2.46)	4.60 (2.28)	4.69 (2.25)	9.28 (3.01)
T ₉	1.06 (1.24)	1.89 (1.54)	2.96 (1.85)	1.58 (1.38)	1.87 (1.52)	3.78 (1.96)	4.44 (2.20)	4.62 (2.20)	7.71 (2.98)
T ₁₀	5.59 (2.47)	10.01 (3.24)	15.61 (4.01)	3.70 (2.03)	5.22 (2.40)	9.09 (2.81)	4.69 (2.18)	7.72 (2.85)	12.40 (3.59)
T ₁₁	1.33 (1.35)	3.11 (1.90)	4.51 (2.24)	1.66 (1.36)	1.80 (1.50)	4.21 (1.92)	4.26 (2.18)	5.29 (2.38)	9.55 (3.11)
T ₁₂	1.33 (1.35)	2.33 (1.68)	3.82 (2.07)	1.57 (1.34)	1.72 (1.44)	3.91 (1.92)	4.06 (2.09)	4.44 (2.06)	8.50 (2.88)
T ₁₃	2.86 (1.83)	4.94 (2.33)	7.88 (2.89)	3.83 (2.08)	5.72 (2.43)	9.51 (3.18)	5.24 (2.41)	7.22 (2.71)	12.46 (3.47)
T ₁₄	2.16 (1.63)	4.44 (2.22)	6.85 (2.71)	2.75 (1.82)	4.78 (2.28)	7.81 (2.87)	4.03 (2.08)	6.25 (2.60)	10.34 (3.22)
F test	*	*	*	*	*	*	*	*	*
S. Em±	0.17	0.08	0.09	0.18	0.04	0.06	0.20	0.09	0.10
CD _{0.05}	0.50	0.24	0.25	0.51	0.10	0.16	0.57	0.25	0.27
CV	19.34	6.56	5.94	18.21	2.96	3.28	14.87	5.36	4.53

Note: *Significant @ 5%; weeds belonging to sedges were not found; BLW- Broad leaf weeds

Growth and yield parameters**Maximum shoot length (cm)**

Maximum shoot length of mulberry was significantly influenced by integrated weed management practices at both 30 and 45

DAP. Among all the treatments, T₃ recorded the highest shoot length of 83.95 cm at 30 DAP and 139.59 cm at 45 DAP, followed by T₉ with 82.36 cm and 137.05 cm, respectively. T₂ and T₈ were the next best treatments, with T₂ recording 80.28 cm

and 134.14 cm and T₈ recording 78.29 cm and 130.96 cm at 30 and 45 DAP, respectively. Among the herbicide-based treatments, T₈ recorded comparatively higher shoot length, followed by T₁₂ (77.31 cm and 132.11 cm) and T₁₁ (75.78 cm and 128.99 cm). The lowest shoot length was recorded in T₁ with 53.81 cm at 30 DAP and 107.29 cm at 45 DAP, followed by T₁₀ (67.95 cm and 108.07 cm) and T₅ (65.91 cm and 109.27 cm).

The superior shoot growth under T₃ may be attributed to effective and prolonged weed suppression resulting in reduced competition for moisture, nutrients, light and space. Plastic mulch also conserves soil moisture and moderates soil temperature, thereby creating favourable conditions for vegetative growth. Similar advantages were noticed in T₉, where early hand weeding combined with cowpea intercropping reduced weed interference and improved the crop microenvironment. The poor performance of the unweeded check indicates severe crop-weed competition during the critical growth period. These findings are in agreement with Das *et al.* (1990) [6], Mir *et al.* (2010) [13] and Sakthivel (2019) [18], who reported improved mulberry growth under mulch-based systems.

Number of shoots per plant

The number of shoots per plant was significantly influenced by integrated weed management practices at both 30 and 45 DAP. Among the treatments, T₃ recorded the maximum number of shoots per plant with 20.57 at 30 DAP and 21.73 at 45 DAP, followed by T₉ with 19.68 and 20.83, respectively. T₂ also recorded a higher number of shoots with 18.54 at 30 DAP and 19.16 at 45 DAP. Among the herbicide-based treatments, T₈ recorded a comparatively higher number of shoots per plant (17.70 and 18.48), followed by T₁₂ (17.43 and 18.24) and T₁₁ (17.19 and 18.07). The minimum number of shoots per plant was recorded in T₁ with 14.25 at 30 DAP and 14.38 at 45 DAP.

The higher number of shoots in T₃ and T₉ may be due to reduced weed competition during the early growth stage, allowing greater availability of nutrients and moisture for shoot initiation and development. Plastic mulch and cowpea as cover crop also improved soil conditions and reduced crop stress, leading to better bud sprouting and shoot proliferation. These findings indicate that sustained weed control has a direct positive influence on vegetative growth in mulberry.

Table 3: Effect of weed management methods on growth parameters of mulberry

Treatments	Maximum shoot length (cm)		Number of shoots per plant		Number of leaves per shoot		Leaf area (cm ²)	
	30 DAP	45 DAP	30 DAP	45 DAP	30 DAP	45 DAP	30 DAP	45 DAP
T ₁	53.81	107.29	14.25	14.38	16.42	22.56	72.79	124.89
T ₂	80.28	134.14	18.54	19.16	18.48	25.75	82.85	137.96
T ₃	83.95	139.59	20.57	21.73	21.57	28.77	90.78	140.80
T ₄	73.46	122.89	16.49	17.35	17.48	24.57	78.71	133.72
T ₅	65.91	109.27	15.18	16.21	16.63	23.65	75.64	129.97
T ₆	69.86	115.93	15.80	16.96	17.73	24.40	77.69	132.13
T ₇	74.60	126.17	16.85	17.72	18.47	25.47	80.39	135.16
T ₈	78.29	130.96	17.70	18.48	18.38	25.63	82.02	136.96
T ₉	82.36	137.05	19.68	20.83	20.89	28.28	88.60	139.42
T ₁₀	67.95	108.07	14.77	15.96	16.56	23.48	74.38	128.08
T ₁₁	75.78	128.99	17.19	18.07	18.44	25.32	80.21	135.84
T ₁₂	77.31	132.11	17.43	18.24	18.66	25.85	81.66	136.36
T ₁₃	70.59	110.20	15.47	16.62	17.51	24.28	76.76	131.32
T ₁₄	72.88	122.00	16.24	17.10	17.54	24.49	78.19	133.01
F test	*	*	*	*	*	*	*	*
S. Em±	2.12	3.86	0.48	0.50	0.40	0.91	1.82	4.87
CD _{0.05}	6.17	11.22	1.41	1.48	1.18	2.67	5.30	14.17
CV	5.01	5.43	5.01	4.96	3.88	6.32	4.25	6.30

Note: *Significant @ 5%; DAP – days after pruning

Number of leaves per shoot

The number of leaves per shoot was significantly influenced by weed management practices at both 30 and 45 DAP. T₃ recorded the highest number of leaves per shoot with 21.57 at 30 DAP and 28.77 at 45 DAP, followed by T₉ with 20.89 and 28.28, respectively. T₁₂, T₂ and T₈ also recorded comparatively higher leaf numbers at 45 DAP, with 25.85, 25.75 and 25.63 leaves per shoot, respectively. The lowest number of leaves per shoot was recorded in T₁ with 16.42 at 30 DAP and 22.56 at 45 DAP, followed by T₁₀ with 16.56 and 23.48, respectively.

The increased leaf number under T₃ and T₉ may be attributed to better crop vigour resulting from lower weed competition and improved resource availability. Effective weed control during the critical period would have enhanced nutrient uptake and photosynthetic activity, ultimately favouring leaf initiation and retention. Thus, better weed suppression contributed substantially to improved canopy development in mulberry.

Leaf area (cm²)

Leaf area was significantly influenced by integrated weed

management practices at both 30 and 45 DAP. The highest leaf area was recorded in T₃ with 90.78 cm² at 30 DAP and 140.80 cm² at 45 DAP, followed by T₉ with 88.60 cm² and 139.42 cm², respectively. T₂ also recorded higher leaf area with 82.85 cm² and 137.96 cm², followed by T₈ with 82.02 cm² and 136.96 cm² at 30 and 45 DAP, respectively. Among herbicide-based treatments, T₈ was found to be superior, followed by T₁₂ (81.66 cm² and 136.36 cm²) and T₁₁ (80.21 cm² and 135.84 cm²). The lowest leaf area was recorded in T₁ with 72.79 cm² at 30 DAP and 124.89 cm² at 45 DAP.

The larger leaf area under T₃ and T₉ may be attributed to better moisture conservation, enhanced nutrient availability and reduced crop-weed competition. Mulching and intercropping not only suppressed weeds but also helped in maintaining favourable soil conditions for leaf expansion and overall vegetative growth. Similar results were reported by Gangawar *et al.* (2000) [8] and Sahida *et al.* (2018) [17], who observed improved mulberry leaf development under mulch-based production systems.

Table 4: Effect of weed management methods on leaf yield of mulberry at 60 DAP

Treatments	Leaf yield (kg plant ⁻¹)	Leaf yield (kg ha ⁻¹ crop ⁻¹)	Per cent increase over control (%)
T ₁	2.36	2618	-
T ₂	3.21	3551	35.64
T ₃	3.40	3766	43.85
T ₄	2.80	3108	18.72
T ₅	2.58	2883	10.12
T ₆	2.70	3001	14.63
T ₇	2.90	3223	23.11
T ₈	3.10	3447	31.67
T ₉	3.31	3668	40.11
T ₁₀	2.49	2773	5.92
T ₁₁	2.95	3275	25.10
T ₁₂	3.00	3333	27.31
T ₁₃	2.64	2934	12.07
T ₁₄	2.75	3051	16.54
F test	*	*	-
S. Em±	0.06	12.68	-
CD _{0.05}	0.18	33.45	-
CV	3.83	6.26	-

Note: *Significant @ 5%; DAP – days after pruning

Leaf yield

Leaf yield of mulberry was significantly influenced by integrated weed management practices. Among all the treatments, T₃ recorded the highest leaf yield of 3.40 kg plant⁻¹ and 3766 kg ha⁻¹ crop⁻¹, followed by T₉ with 3.31 kg plant⁻¹ and 3668 kg ha⁻¹ crop⁻¹ and T₂ with 3.21 kg plant⁻¹ and 3551 kg ha⁻¹ crop⁻¹. Among the herbicide-based treatments, T₈ recorded higher leaf yield of 3.10 kg plant⁻¹ and 3447 kg ha⁻¹ crop⁻¹. The lowest leaf yield was recorded in T₁ with 2.36 kg plant⁻¹ and 2618 kg ha⁻¹ crop⁻¹. The per cent increase in leaf yield over control was highest in T₃ (43.85%), followed by T₉ (40.11%), T₂ (35.64%) and T₈ (31.67%).

The higher leaf yield under T₃ may be attributed to effective weed suppression, improved soil moisture conservation and better crop growth, which resulted in greater biomass accumulation. T₉ also performed well due to sustained weed suppression by cowpea intercropping. Among chemical treatments, T₈ was superior, indicating that herbicide application combined with mulching can effectively improve mulberry productivity. Similar findings were reported by Das *et al.* (1990)^[6], Setua *et al.* (2009)^[19], Rajegowda *et al.* (2020)^[16] and Khare *et al.* (2023)^[11].

Conclusion

The integrated weed management practices significantly influenced weed density, weed dry weight, growth and yield of mulberry. Among all the treatments, hand weeding immediately after pruning followed by plastic mulching recorded the lowest weed density and weed dry weight, along with maximum shoot length, number of shoots, number of leaves, leaf area and leaf yield. This treatment was closely followed by hand weeding immediately after pruning and intercropping with fodder cowpea. Among the herbicide-based treatments, paraquat dichloride followed by plastic mulching proved to be more effective than other chemical weed management options. Therefore, integration of early hand weeding with plastic mulching or legume intercropping can be considered as an efficient, practical and sustainable strategy for weed management in mulberry cultivation.

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