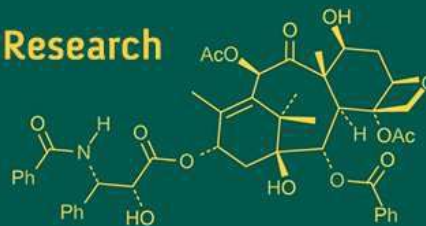


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## Effect of different weed management practices on performance of silkworm *Bombyx mori* L.

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### Abstract

An experiment was carried out during 2025 to study the effect of different weed management practices in mulberry on weed suppression and silkworm performance. The experiment was conducted in Randomized Complete Block Design with fourteen treatments and three replications. Among all the treatments, T<sub>3</sub>-hand weeding immediately after pruning followed by plastic mulching within a week recorded the shortest fifth instar larval duration (8.18 days), maximum grown-up larval weight (45.34 g per 10 larvae), minimum larval mortality (1.76%), maximum larval progression (98.24%), maximum cocoon yield by weight (23.67 kg per 10,000 larvae) and superior silk filament characteristics. This was followed by T<sub>9</sub>-hand weeding immediately after pruning and intercropping with fodder cowpea. Among the herbicide-based treatments, T<sub>8</sub>-paraquat dichloride 24% SL @ 1.25 kg a.i ha<sup>-1</sup> followed by plastic mulching performed better than the other chemical treatments. In contrast, T<sub>11</sub>-indaziflam + glyphosate followed by wheel hoe weeding recorded poor silkworm performance and cocoon traits. The study indicated that hand weeding immediately after pruning followed by plastic mulching is the most suitable weed management practice in mulberry for improved silkworm performance and cocoon productivity.

**Keywords:** Mulberry, weed management, plastic mulching, silkworm performance, cocoon yield, silk filament

### Introduction

Mulberry (*Morus alba* L.) is the sole food plant of the silkworm, *Bombyx mori* L., and the success of sericulture largely depends on the quantity as well as quality of mulberry leaves supplied to the worms. Since the silkworm is a monophagous insect, the nutritive value, moisture content and biochemical composition of mulberry leaves directly influence larval growth, cocoon yield and silk quality. Therefore, agronomic practices that improve mulberry growth and leaf quality can directly enhance silkworm performance and silk productivity.

Among the different constraints affecting mulberry productivity, weeds are one of the major factors responsible for reducing leaf yield and leaf quality. Weeds compete with mulberry plants for nutrients, moisture, light and space, thereby adversely affecting crop growth and productivity. They also interfere with nutrient uptake and suppress the development of healthy mulberry plants, resulting in poor quality leaves for silkworm feeding (Aldrich and Kremer, 1997; Krishna *et al.*, 2012; Muniyappa and Shivakumar, 1994) [1, 9, 11]. The composition of weed flora in mulberry gardens differs with locality and management practices, and both grasses and broad-leaved weeds are commonly predominant in irrigated mulberry ecosystems (Bali and Pandit, 2014; Shanmugam *et al.*, 2012) [2, 19].

Several weed management practices such as hand weeding, mechanical weeding, mulching, intercropping and herbicidal control have been recommended in mulberry cultivation. Earlier studies have shown that herbicides can effectively reduce weed growth and improve mulberry productivity when used properly (Kasiviswanathan *et al.*, 1978; Muniyappa and Bomme Gowda, 1988; Shivakumar, 1992) [8, 10, 20]. However, indiscriminate or unsuitable use of herbicides may adversely influence leaf quality and, in turn, affect silkworm growth, cocoon yield and silk quality (Muniyappa, 1990; Suresh Babu, 1997) [12, 22]. Therefore, weed management practices in mulberry should be selected not only on the basis of weed control efficiency but also on their safety to silkworms.

Integrated weed management involving manual, cultural and judicious chemical methods offers better scope for sustainable mulberry production.

Use of crop residues, mulches and leguminous intercrops has been found to suppress weed growth effectively while improving soil conditions and crop performance (Mohler and Callaway, 1992; Setua *et al.*, 2006; Setua *et al.*, 2009) [13, 16 17]. Mulching and intercropping in mulberry were also reported to improve growth and yield and support better silkworm rearing performance (Arun Kumar, 2013; Rajegowda *et al.*, 2020; Islam *et al.*, 2023) [14, 7]. Plastic mulching and other mulches have also been found beneficial in improving mulberry growth and yield through reduced weed interference and better moisture conservation (Sahida *et al.*, 2018) [15]. In this context, the present investigation was undertaken to study the effect of different weed management practices in mulberry on weed suppression and the subsequent performance of silkworm, *Bombyx mori* L.

## 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 was established with fourteen treatment combinations, viz., T<sub>1</sub>-unweeded check, T<sub>2</sub>-hand weeding twice (one immediately after pruning and second on 25 DAP), T<sub>3</sub>-hand weeding immediately after pruning and mulching with plastic within a week, T<sub>4</sub>-glyphosate @ 6 ml L<sup>-1</sup> at 2 to 4 DAP + wheel hoe weeder at 40<sup>th</sup> DAP, T<sub>5</sub>-early post-emergence application of propaquizafop 10% EC @ 100 g a.i ha<sup>-1</sup> at 2 to 4 leaf stage of weed + wheel hoe weeder at 40<sup>th</sup> DAP, T<sub>6</sub>-early post-emergence application of propaquizafop 10% EC @ 100 g a.i ha<sup>-1</sup> at 2 to 4 leaf stage of weed + mulching with plastic at 15 days after application, T<sub>7</sub>-post-emergence application of paraquat dichloride 24% SL @ 1.25 kg a.i ha<sup>-1</sup> at 2 to 4 leaf stage of weed + wheel hoe weeder at 40<sup>th</sup> DAP, T<sub>8</sub>-post-emergence application of paraquat dichloride 24% SL @ 1.25 kg a.i ha<sup>-1</sup> at 2 to 4 leaf stage of weed + mulching with plastic at 15 days after application, T<sub>9</sub>-hand weeding immediately after pruning and intercropping with fodder cowpea, T<sub>10</sub>-mechanical weeding by using power tiller at 20 and 40 DAP, T<sub>11</sub>-post-emergence application of indaziflam 20 + glyphosate IPA 540 SC (1.65% w/w + 44.63% w/w) @ 1050 g a.i ha<sup>-1</sup> at 2 to 4 DAP + wheel hoe weeder at 40<sup>th</sup> DAP, T<sub>12</sub>-post-emergence application of indaziflam 20 + glyphosate IPA 540 SC (1.65% w/w + 44.63% w/w) @ 1050 g a.i ha<sup>-1</sup> at 2 to 4 DAP + mulching with plastic at 15 days after application, T<sub>13</sub>-quizalofop-p-butyl @ 1.5 ml L<sup>-1</sup> + imazethapyr @ 1.5 ml L<sup>-1</sup> at 2 to 4 DAP + wheel hoe weeder at 40<sup>th</sup> DAP and T<sub>14</sub>-quizalofop-p-butyl @ 1.5 ml L<sup>-1</sup> + imazethapyr @ 1.5 ml L<sup>-1</sup> 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 rearing was conducted by using the different treatment leaves at Department of Sericulture, UAS, GKVK, Bengaluru. The experiment was laid out in a Complete Randomized Design (CRD) with three replications and eight treatments, comprising of different proportions of hydrogels. Prior to commencement of rearing, the rearing room with rearing stands were cleaned, washed thoroughly and properly disinfected and, the bivoltine double hybrid (FC2 × FC1), third instar silkworms procured from Registered

Chawki Rearing Centre and reared as per the protocol (Dandin and Giridhar, 2014) [5]. After the fourth moult the samples were drawn randomly for the silkworm parameters viz., grownup larval weight, fifth instar larval duration, larval mortality, larval progression, single cocoon weight, cocoon shell weight, single pupal weight, cocoon shell ratio, average filament length, non-breakable filament length, filament weight and denier were recorded as per the standard procedure.

The data recorded on various parameters were subjected to Fisher's method of Analysis of Variance (ANOVA) and interpreted according to and interpreted according to Sundararaj *et al.* (1972) [21]. The level of significance used in F and t-tests was P = 0.05. The critical difference (CD) values were computed where the F test was found significant.

## Results and Discussion

The results and discussion on the effect of different weed management practices in mulberry on silkworm performance are presented below.

### Larval parameters

Larval parameters of silkworm were significantly influenced by feeding mulberry leaves harvested from plots subjected to different weed management practices. Among all the treatments, T<sub>3</sub> recorded the shortest fifth instar larval duration (8.18 days) and total larval duration (23.78 days), followed by T<sub>9</sub> with 8.25 and 23.85 days and T<sub>2</sub> with 8.30 and 23.90 days, respectively. Among the herbicide-based treatments, T<sub>8</sub> recorded comparatively shorter larval duration of 8.37 days in fifth instar and 23.97 days in total larval duration, followed by T<sub>12</sub> with 8.43 and 24.03 days, respectively. In contrast, T<sub>11</sub> recorded the longest fifth instar larval duration (9.41 days) and total larval duration (25.13 days).

**Table 1:** Impact of feeding mulberry leaves of treated plots on larval duration and larval weight of silkworm (FC2 × FC1)

| Treatment          | Fifth instar larval duration (days) | Total larval duration (Days) | Grown-up larval weight (g/10 larvae) |
|--------------------|-------------------------------------|------------------------------|--------------------------------------|
| T <sub>1</sub>     | 8.75                                | 24.35                        | 32.10                                |
| T <sub>2</sub>     | 8.30                                | 23.90                        | 42.59                                |
| T <sub>3</sub>     | 8.18                                | 23.78                        | 45.34                                |
| T <sub>4</sub>     | 8.56                                | 24.16                        | 38.49                                |
| T <sub>5</sub>     | 8.65                                | 24.25                        | 34.83                                |
| T <sub>6</sub>     | 8.58                                | 24.18                        | 36.40                                |
| T <sub>7</sub>     | 8.47                                | 24.07                        | 39.95                                |
| T <sub>8</sub>     | 8.37                                | 23.97                        | 41.83                                |
| T <sub>9</sub>     | 8.25                                | 23.85                        | 43.94                                |
| T <sub>10</sub>    | 8.70                                | 24.30                        | 33.43                                |
| T <sub>11</sub>    | 9.41                                | 25.13                        | 30.37                                |
| T <sub>12</sub>    | 8.43                                | 24.03                        | 41.65                                |
| T <sub>13</sub>    | 8.60                                | 24.20                        | 35.53                                |
| T <sub>14</sub>    | 8.51                                | 24.11                        | 37.53                                |
| F test             | *                                   | *                            | *                                    |
| S. Em ±            | 0.12                                | 0.05                         | 0.18                                 |
| CD <sub>0.05</sub> | 0.34                                | 0.13                         | 0.56                                 |
| CV                 | 1.94                                | 0.32                         | 0.83                                 |

**Note:** \*Significant @ 5%

A similar trend was observed in grown-up larval weight, larval mortality and larval progression. T<sub>3</sub> recorded the maximum grown-up larval weight (45.34 g per 10 larvae),

minimum larval mortality (1.76%) and maximum larval progression (98.24%), followed by T<sub>9</sub> and T<sub>2</sub>. Among the herbicide-based treatments, T<sub>8</sub> recorded comparatively better larval performance than the other chemical

treatments. In contrast, T<sub>11</sub> recorded the minimum larval weight (30.37 g), maximum larval mortality (81.14%) and minimum larval progression (18.85%), indicating severe adverse effects on silkworm growth and survival.

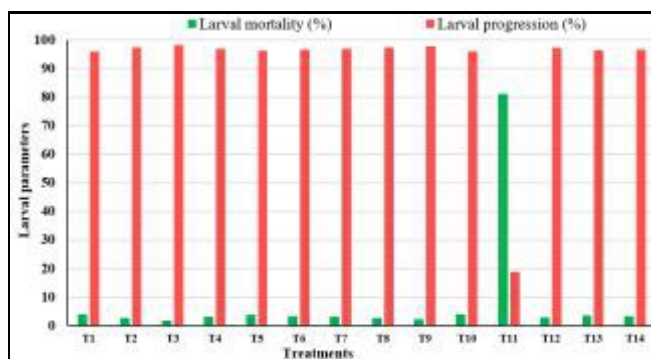


**Fig 1:** Impact of feeding mulberry leaves of treated plots on larval mortality and larval progression of silkworm (FC2 × FC1)

The superior larval performance observed in T<sub>3</sub> and T<sub>9</sub> may be attributed to better mulberry leaf quality under effective weed suppression. Early hand weeding after pruning followed by plastic mulching or cowpea intercropping improved mulberry leaf quality by increasing chlorophyll, protein, carbohydrate and moisture content. These nutrient-rich leaves enhanced silkworm growth, survival and cocoon productivity, which is in conformity with the findings of Arun Kumar (2013) [3], Rajegowda *et al.* (2020) [14] and

Islam *et al.* (2023) [7]. On the other hand, the poor larval performance in T<sub>11</sub> may be due to possible residual toxicity of the herbicidal combination, which might have adversely affected larval feeding, digestion and metabolism, resulting in higher mortality and poor larval progression. Similar observations on the adverse influence of unsuitable chemical weed control measures on silkworm performance were reported by Muniyappa (1990) [12], Shivakumar (1992) [20] and Suresh Babu (1997) [22].

**Table 2:** Impact of feeding mulberry leaves of treated plots on cocoon parameters of silkworm (FC2 × FC1)

| Treatment          | Cocoon weight (g) | Cocoon shell weight (g) | Pupal weight (g) | Cocoon shell ratio (%) | Cocoon yield by number (No./10,000 larvae) | Cocoon yield by weight (kg/10,000 larvae) |
|--------------------|-------------------|-------------------------|------------------|------------------------|--------------------------------------------|-------------------------------------------|
| T <sub>1</sub>     | 2.14              | 0.43                    | 1.66             | 20.05                  | 9602                                       | 20.56                                     |
| T <sub>2</sub>     | 2.34              | 0.51                    | 1.82             | 21.60                  | 9742                                       | 22.70                                     |
| T <sub>3</sub>     | 2.38              | 0.53                    | 1.85             | 21.89                  | 9823                                       | 23.67                                     |
| T <sub>4</sub>     | 2.24              | 0.47                    | 1.74             | 20.89                  | 9686                                       | 21.50                                     |
| T <sub>5</sub>     | 2.18              | 0.45                    | 1.69             | 20.28                  | 9628                                       | 20.91                                     |
| T <sub>6</sub>     | 2.21              | 0.46                    | 1.71             | 20.52                  | 9661                                       | 21.26                                     |
| T <sub>7</sub>     | 2.27              | 0.48                    | 1.77             | 21.08                  | 9700                                       | 21.93                                     |
| T <sub>8</sub>     | 2.31              | 0.50                    | 1.81             | 21.41                  | 9724                                       | 22.48                                     |
| T <sub>9</sub>     | 2.36              | 0.52                    | 1.84             | 21.74                  | 9769                                       | 23.26                                     |
| T <sub>10</sub>    | 2.16              | 0.44                    | 1.69             | 20.17                  | 9611                                       | 20.67                                     |
| T <sub>11</sub>    | 1.66              | 0.27                    | 1.40             | 17.79                  | 1885                                       | 3.22                                      |
| T <sub>12</sub>    | 2.29              | 0.49                    | 1.79             | 21.24                  | 9729                                       | 22.29                                     |
| T <sub>13</sub>    | 2.20              | 0.46                    | 1.71             | 20.53                  | 9659                                       | 21.16                                     |
| T <sub>14</sub>    | 2.24              | 0.47                    | 1.73             | 20.73                  | 9690                                       | 21.61                                     |
| F test             | *                 | *                       | *                | *                      | *                                          | *                                         |
| S. Em ±            | 0.01              | 0.04                    | 0.01             | 0.25                   | 53.87                                      | 0.32                                      |
| CD <sub>0.05</sub> | 0.03              | 0.01                    | 0.05             | 0.76                   | 156.06                                     | 0.93                                      |
| CV                 | 0.88              | 1.53                    | 1.58             | 2.18                   | 1.01                                       | 2.29                                      |

**Note:** \*Significant @ 5%

### Cocoon parameters

Cocoon parameters were significantly influenced by feeding mulberry leaves obtained from different weed management practices. Among all the treatments, T<sub>3</sub> recorded the maximum cocoon weight (2.38 g), cocoon shell weight (0.53 g), pupal weight (1.85 g), cocoon shell ratio (21.89%), cocoon yield by number (9823 per 10,000 larvae) and cocoon yield by weight (23.67 kg per 10,000 larvae), followed by T<sub>9</sub> with 2.36 g cocoon weight, 0.52 g cocoon shell weight, 1.84 g pupal weight, 21.74 per cent cocoon shell ratio, 9769 cocoons and 23.26 kg cocoon yield by weight and T<sub>2</sub> with 2.34 g cocoon weight, 0.51 g cocoon shell weight, 1.82 g pupal weight, 21.60 per cent cocoon

shell ratio, 9742 cocoons and 22.70 kg cocoon yield by weight. Among the herbicide-based treatments, T<sub>8</sub> recorded comparatively superior cocoon parameters with 2.31 g cocoon weight, 0.50 g cocoon shell weight, 1.81 g pupal weight, 21.41 per cent cocoon shell ratio, 9724 cocoons and 22.48 kg cocoon yield by weight. In contrast, T<sub>11</sub> recorded the lowest cocoon weight (1.66 g), cocoon shell weight (0.27 g), pupal weight (1.40 g), cocoon shell ratio (17.79%), cocoon yield by number (1885 per 10,000 larvae) and cocoon yield by weight (3.22 kg per 10,000 larvae).

The maximum cocoon weight, cocoon shell weight and cocoon shell ratio observed in T<sub>3</sub> and T<sub>9</sub> may be attributed to healthier larval growth and better silk gland development

resulting from feeding nutritionally superior mulberry leaves. Better leaf nutrition also promoted fibroin-sericin synthesis, resulting in heavier cocoons, higher shell ratio and improved cocoon productivity. These results are in agreement with the findings of Arun Kumar (2013) <sup>[3]</sup>, Rajegowda *et al.* (2020) <sup>[14]</sup> and Islam *et al.* (2023) <sup>[7]</sup>. Similarly, paraquat dichloride followed by mulching effectively controlled weeds and maintained good leaf

quality, thereby supporting favourable cocoon parameters. In contrast, the indaziflam + glyphosate treatment (T<sub>11</sub>) showed extremely poor cocoon performance, which may be due to high toxicity and consequent impairment of larval growth and cocoon formation, as also indicated by Muniyappa (1990) <sup>[12]</sup>, Shivakumar (1992) <sup>[20]</sup> and Suresh Babu (1997) <sup>[22]</sup>.

**Table 3:** Impact of feeding mulberry leaves of treated plots on silk filament characteristics of silkworm (FC2 × FC1)

| Treatment          | Average filament length (m) | Non-breakable filament length (m) | Filament weight (g) | Denier |
|--------------------|-----------------------------|-----------------------------------|---------------------|--------|
| T <sub>1</sub>     | 1233                        | 1100                              | 0.37                | 2.74   |
| T <sub>2</sub>     | 1323                        | 1137                              | 0.43                | 2.85   |
| T <sub>3</sub>     | 1341                        | 1149                              | 0.47                | 2.96   |
| T <sub>4</sub>     | 1283                        | 1118                              | 0.40                | 2.78   |
| T <sub>5</sub>     | 1254                        | 1105                              | 0.38                | 2.75   |
| T <sub>6</sub>     | 1269                        | 1113                              | 0.39                | 2.77   |
| T <sub>7</sub>     | 1295                        | 1126                              | 0.41                | 2.80   |
| T <sub>8</sub>     | 1314                        | 1136                              | 0.43                | 2.88   |
| T <sub>9</sub>     | 1332                        | 1144                              | 0.44                | 2.93   |
| T <sub>10</sub>    | 1246                        | 1104                              | 0.37                | 2.74   |
| T <sub>11</sub>    | 944                         | 681                               | 0.26                | 2.26   |
| T <sub>12</sub>    | 1306                        | 1132                              | 0.43                | 2.86   |
| T <sub>13</sub>    | 1262                        | 1115                              | 0.39                | 2.77   |
| T <sub>14</sub>    | 1278                        | 1121                              | 0.40                | 2.79   |
| F test             | *                           | *                                 | *                   | *      |
| S. Em ±            | 32.73                       | 35.72                             | 0.02                | 0.90   |
| CD <sub>0.05</sub> | 98.68                       | 104.82                            | 0.06                | 0.27   |
| CV                 | 4.75                        | 4.92                              | 4.28                | 4.76   |

**Note:** \*Significant @ 5%

### Silk filament characteristics

Silk filament characteristics differed significantly among the treatments. Among all the treatments, T<sub>3</sub> recorded the maximum average filament length (1341 m), non-breakable filament length (1149 m), filament weight (0.47 g) and denier (2.96), followed by T<sub>9</sub> with 1332 m average filament length, 1144 m non-breakable filament length, 0.44 g filament weight and 2.93 denier and T<sub>2</sub> with 1323 m average filament length, 1137 m non-breakable filament length, 0.43 g filament weight and 2.85 denier. Among the herbicide-based treatments, T<sub>8</sub> recorded comparatively better filament quality with 1314 m average filament length, 1136 m non-breakable filament length, 0.43 g filament weight and 2.88 denier. In contrast, T<sub>11</sub> recorded the minimum values for average filament length (944 m), non-breakable filament length (681 m), filament weight (0.26 g) and denier (2.26).

The better filament characteristics recorded in T<sub>3</sub> and T<sub>9</sub> may be due to improved larval nourishment and proper silk gland development resulting from feeding of better quality mulberry leaves. Good leaf quality supports silk protein synthesis and continuous spinning, leading to increased filament length, filament weight and denier. The present findings are in conformity with those of Arun Kumar (2013) <sup>[3]</sup>, Rajegowda *et al.* (2020) <sup>[14]</sup> and Islam *et al.* (2023) <sup>[7]</sup>. In contrast, the poor filament traits recorded in T<sub>11</sub> may be attributed to reduced larval growth and silk gland activity caused by persistent herbicide residue effects, resulting in poor silk deposition and weaker filaments. Similar findings were also reported by Muniyappa (1990) <sup>[12]</sup>, Shivakumar (1992) <sup>[20]</sup> and Suresh Babu (1997) <sup>[22]</sup>.

The present investigation clearly indicated that weed management practices in mulberry exerted a marked influence not only on weed suppression but also on silkworm growth, cocoon yield and silk filament quality.

Early hand weeding after pruning followed by plastic mulching or cowpea intercropping improved mulberry leaf quality by increasing chlorophyll, protein, carbohydrate and moisture content. These nutrient-rich leaves enhanced silkworm growth, survival and cocoon productivity (Muniyappa, 1990; Suresh Babu 1997) <sup>[12, 22]</sup>. Better leaf nutrition also promoted silk gland development and fibroin-sericin synthesis, resulting in heavier cocoons, higher shell ratio and improved filament length and strength. Similar beneficial effects of intercrops, mulches and integrated weed management practices in mulberry were reported by, Setua *et al.* (2009) <sup>[17]</sup>, Arun Kumar (2013) <sup>[3]</sup>, Sahida *et al.* (2018) <sup>[15]</sup>, and Islam *et al.* (2023) <sup>[7]</sup>.

In contrast, the indaziflam + glyphosate treatment (T<sub>11</sub>) showed extremely poor cocoon and filament parameters due to poor larval growth and reduced productivity. Residues of these persistent herbicides likely affected silkworm digestion and metabolism, impairing silk gland development and fibroin production, which resulted in smaller cocoons, thinner shells and weaker silk filaments. Thus, weed management practices in mulberry should be selected not only on the basis of weed control efficiency but also on their safety and suitability for silkworm rearing, as suggested by Muniyappa (1990) <sup>[12]</sup>, Shivakumar (1992) <sup>[20]</sup> and Suresh Babu (1997) <sup>[22]</sup>.

### Conclusion

Weed management practices significantly influenced weed control, mulberry leaf quality and silkworm performance. Hand weeding immediately after pruning followed by plastic mulching (T<sub>3</sub>) recorded the shortest larval duration, better larval growth, reduced larval mortality, higher larval progression, improved cocoon parameters and superior filament characteristics. Hand weeding immediately after

pruning followed by intercropping with fodder cowpea (T<sub>9</sub>) also showed comparable results. Among the herbicide treatments, paraquat dichloride followed by plastic mulching (T<sub>8</sub>) performed relatively better. In contrast, indaziflam + glyphosate followed by wheel hoeing (T<sub>11</sub>) recorded inferior larval growth, poor survival, reduced cocoon yield and inferior silk quality. Therefore, hand weeding immediately after pruning followed by plastic mulching may be considered the most suitable weed management practice in mulberry for sustainable sericulture and higher cocoon productivity.

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