Effect of Drought on the Growth and Development of Mulberry

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Abstract

Effects of drought on plants range from morphological to molecular level. The severity of drought depends on many factors like rain fall distribution, temperature, water holding capacity of soils and the severity varies from crop to crop. The quality and quantity of Mulberry leaf, the sole food source of silkworm *Bombyx mori* L. plays a major role in sericulture industry. Carbohydrates, Proteins and are the major plant metabolites which influence quality and quantity of leaf yield. Phenols are responsible for plant defense mechanism and synthesis of various metabolites. Analysis of mulberry leaf helps in identification of mulberry leaf quality there by selection for silkworm feeding. Hence the present study was carried out to know the effect of drought on mulberry growth, development, and biochemical and post cocoon parameters in control and drought induced plants. In this study it was found that growth parameters like total plant height (cm), fresh weight of 100 leaves, (g), Single cocoon weight (g), Single cocoon weight (g) etc. were decreased in drought induced plants. Biochemical analysis in drought induced plants showed significant changes like protein (%), carbohydrate (mg/g) and chlorophyll (mg/g) content. The post cocoon parameters like larval weight (g), number of cocoons harvested, cocoon weight (g), cocoon shell weight(g), cocoon shell percentage (%), total filament length (m), Non breakable filament length (m), denier etc. were decreased in drought induced plants.

Keywords: Mulberry, drought, *V*₁, Mysore local, leaf quality, silkworm.
INTRODUCTION
Mulberry, the main food source of silkworm *Bombyx mori* L. has an economic importance to sericulture industry. The quality and quantity of mulberry leaf yield has great influence on silkworm crop. Various factors like sustainable agro climatic conditions like water availability, good soil properties, mulberry varieties, crop protection play major role on quantity and quality of mulberry leaf. Among these parameters water is vital for plants; plants absorb all the nutrients which are required for their nutrition through water only. In India rainfall is the main water source which depends on two major monsoons like south west and north east. But these monsoons are not regular and they are not well spread throughout the year and also they are very scanty. Mulberry being a perennial plant suffer want of water major portion of the year. In India all most all the states suffer drought conditions. Especially southern states like Andhra Pradesh, Karnataka, Tamilnadu where most of the sericulture us concentrated. Mulberry influence due to drought conditions representing poor cocoon crop.

The effect of feeding the leaves of the mulberry (*Morus* spp.) on the larval growth, cocoon yield and other economic characters of the cocoons has been reported by a number of investigators. The nutritiousness and palatability offer better criteria for the superiority of one type of leaf over the other as food for the silkworm (Kafani, 1960 and Parpiev, 1968) concluded that the water content in the leaves may serve as one of the criteria in assessing their quality. Food quality greatly influences larval growth, weight of cocoons, silk yield and physical-mechanical properties of silk thread as reported by Samokhvalova *et al*., 1972. The nutritional status of mulberry leaf which influences the economic characters of silkworm crop depends upon the level of leaf moisture, total protein, total carbohydrates and total minerals (Bongale *et al*., 1991).The influence of various agronomical practices in India on leaf quality of mulberry has been well documented by various authors (Das and Vijayaraghavan, 1990).

Hence the present study is aimed to know the effect of drought or water stress on the two to important two mulberry varieties viz. V1 and Mysore local.

MATERIALS AND METHODS

**Plant Growth and Development and biochemical parameters:**

The present study was conducted in the department of Sericulture, Sri Padmavati Mahila University, Tirupati (2014-2016). One year after establishment of plants water stress was induced to the selected varietal plants. Stress was imposed by giving specific volume of water (two liters) in different schedules like five and seven days.

Growth and development and biochemical studies were studied three months after
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Treatment plants. Two mulberry varieties namely V₁ and Mysore local were planted split plot design keeping control for both the varieties. The experimental plot was designed in split plot design was maintain under natural photoperiod.

The treatments are recorded like this:
T1V1-V1 mulberry variety with five days water schedule, T1ML-Mysore local mulberry variety with five days water schedule, T2V1-V1 mulberry variety with seven days water schedule and T2ML-Mysore local mulberry variety with seven days water schedule.

**Determination of Growth and Development Parameters:**

For this study three plants were randomly selected from both V₁ and Mysore local varieties in control and drought induced blocks with different water schedules.

**Total plant height (cm):**

Total number of primary branches and height of primary branches was calculated. Total height of the plant was obtained by multiplying the average height of the branches with number of primary branches.

\[
\text{Total plant height (cm)} = \frac{\text{Total length of branches}}{\text{Total number of branches}}
\]

**Number of Leaves per plant:**

The samples selected for leaf are determinations were utilized for counting number of leaves per plant.

**Weight of 100 fresh leaves (gm):**

100 leaves were taken in a polythene cover and immediately weight was recorded in the laboratory.

**Leaf moisture percentage:**

Moisture content of the leaves was determined on dry weight basis. 100 fresh leaves were harvested randomly from three plants in each variety and fresh weight was taken. That leaves were dried in hot air oven at 60⁰c for 72 hours (three days). Moisture percentage was calculated by using the formula:
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\[ \text{LMP} = \frac{\text{Weight of fresh leaves} - \text{Weight of dry leaves}}{\text{Weight of fresh leaves}} \times 100 \]

Relative Water Content (RWC):
Leaf relative water content (RWC) was estimated according to the method of Gonzalez and González-Vilar (2001). RWC was recorded from four leaves of the fully expanded leaf from the top of the main stem from each plant. Harvested leaf, fresh weight were recorded within 15 minutes, then leaf samples were soaked in 20 ml distilled water for 8 hours and blotted for surface drying and water saturated leaf weight was recorded. The samples were oven dried at 80°C for 48 hr. The leaf relative water content was calculated using the following formula RWC Where FW is fresh weight, DW is dry weight, and TW are turgid weighted.

Determination of biochemical Parameters:

Protein estimation: (%)
Protein content of leaves was estimated by Lowry’s method (Lowry et al., 1951).

Total Carbohydrate estimation by Anthrone method (mg /g):
The total carbohydrate was estimated by anthrone method (Hedge and Hofreiter, 1962).

\[ \text{Amount of carbohydrate present in 100mg of the sample} = \frac{\text{mg of glucose}}{\text{Volume of test sample}} \]

Total Phenols estimation: (mg /g):
Total phenol content was estimated using Folin-ciocalteau method (Malick and Singh, 1980).

Total Chlorophyll estimation: (mg /g):
The chlorophyll content in leaves was estimated by the method of Arnon (1949). The amount of chlorophyll present in the extract was calculated using the following formula and noted in mg/gram weight of tissue.

\[ \text{mg chlorophyll a/g tissue} = 12.7 (A_{663}) - 2.69 (A_{645}) \times \frac{v}{1000 \times w} \]
mg chlorophyll b/g tissue = 22.9 (A_{645})-4.68 (A_{663}) \times \frac{V}{1000} x w

and

mg total chlorophyll/g tissue = 20.2 (A_{645})-8.02 (A_{663}) \times \frac{V}{1000} x w

where A=absorbance at specific wavelengths,
V=final volume of chlorophyll extract in 80% acetone
and W=fresh weight of tissue extracted.

Silkworm bioassay studies:
Three disease free layings (dfls) of commercially popular double hybrid of (Bv X Bv) silk worms were selected for this study and made into six baches of three dfls each and studied separately feeding with drought induced i.e. five and seven days water schedule both two varieties (V1 and Mysore local) of keeping control.

During, after rearing the following parameters were studied. Results were placed in the table-3 and table-4.

(i) Larval weight (g):
Larval weight was recorded every day after first feeding in all the three instars, from 3rd instar till mounting. For these study ten larvae at randomly were selected from control as well as treated.

(ii) Number of cocoons harvested:
Cocoons were harvested on fifth day after mounting by ensuring complete development of pupae and the number was recorded.

(iii) Cocoon weight (g):
Cocoons were stifling by keeping them in hot air oven for three days at 70°C . The following cocoon parameters ware studied and to assess the quality.

The single cocoon weight was assessed as the average of 10 cocoons taken at random for each treatment.

(iv) Cocoon shell weight (g):
The single shell weight was calculated as the average of 10 shells used for cocoon weight assessment.
(v) **Cocoon shell percentage (%)**:  
It is calculated with the formula

\[
\text{Cocoon shell percentage} = \left( \frac{\text{Weight of the cocoon shell}}{\text{Weight of the entire cocoon}} \right) \times 100
\]

(vi) **Average Filament Length (m)**:  
10 cocoons were cooked and reeled on an epprouvette (circumference 1.125m) and average filament length in meters is calculated as per the standard procedure.

(vii) **Non breakable filament length (m)**:  
The total non breakable filament length was calculated by used the formula

\[
\text{Non breakable silk length} = \frac{\text{Total filament length}}{1 + \text{number of breaks}}
\]

(viii) **Filament Denier**:  
Denier which represents the size of the yarn is the weight in grams of 9000 meters of the yarn / filament. The denier (size) was calculated using the formula

\[
\text{Denier} = \left( \frac{\text{Weight in gram of filament}}{\text{Length in meter of filament}} \right) \times 9000
\]

**RESULTS AND DISCUSSION**

The present study revealed that drought stress on V1 and Mysore local varieties shows significant changes on growth and development and biochemical parameters, which were indicated in Table-1 and Table-2.

**Total plant height (cm)**:  
Total plant height observed in V1 leaves 284 cm compared to T1V1. The present of reduction in treated plants in 174 cm with 38% with T2V1 the height of the plant in treated plants was 143 cm with 49% of decreasing in plant height. In Mysore local which is rainfed variety the height of the T1ML in 189 cm, 154 cm in T2ML with compared to 236 cm in controlled plants. So that percentage of reduction 19 and 34% respectively.
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Number of Leaves per plant:
Number of leaves per plant observed in V1 leaves 208.4 compared to T1V1. The present of reduction in treated plants in 137 with 34% with T2V1 the number of leaves per plant in treated plants was 96.6 with 53% of decreasing in number of leaves per plant. In Mysore local which is rainfed variety the number of leaves per plant, T1ML in 156.8, 119 in T2ML with compared to 236 cm in controlled plants. So that percentage of reduction 32% and 48% respectively.

Weight of 100 fresh leaves (g):
Weight of 100 fresh leaves observed in V1 leaves 404.80g compared to T1V1. The present of reduction in treated plants in 298.66g with 26% with T2V1 the weight of 100 fresh leaves in treated plants was 136.24g with 66% of decreasing in weight of 100 fresh leaves. In Mysore local which is rainfed variety the weight of 100 fresh leaves, the treated plants with T1ML in 136.25g, 98.36g in T2ML with compared to 298.03 cm in controlled plants. So that percentage of reduction 54% and 66% respectively.

Leaf moisture percentage: (%)
Leaf moisture percentage observed in V1 leaves 74.30% compared to T1V1. The present of reduction in treated plants in 53.69% with 27% with T2V1 the leaf moisture percentage in treated plants was 43.23 with 41% of decreasing in leaf moisture percentage. In Mysore local which is rainfed variety the leaf moisture percentage, the treated plants with T1ML in 53.69, 43.23 in T2ML with compared to 63.28% in controlled plants. So that percentage of reduction 22% and 42% respectively.

Relative water content: (%)
Leaf moisture percentage observed in V1 leaves 44.63% compared to T1V1. The present of reduction in treated plants in 36.24 with 18% with T2V1 the relative water content in treated plants was 22.03% with 50% of decreasing in relative water content. In Mysore local which is rainfed variety the relative water content, the treated plants with T1ML in 19.83, 16.24 in T2ML with compared to 28.36% in controlled plants. So that percentage of reduction 30% and 42% respectively.
Table 1: Growth parameters of Mulberry (Victory-1 and Mysore local)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Growth parameters</th>
<th>Mulberry variety</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Victory-1</td>
<td>Mysore local</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Control 5-days</td>
<td>7-days</td>
<td>Control 5-days</td>
</tr>
<tr>
<td>1.</td>
<td>Total plant height</td>
<td>284</td>
<td>174</td>
<td>143</td>
</tr>
<tr>
<td>2.</td>
<td>Number of leaves per plant</td>
<td>208.4</td>
<td>137</td>
<td>96.6</td>
</tr>
<tr>
<td>3.</td>
<td>Weight of 100 fresh leaves</td>
<td>404.80</td>
<td>298.66</td>
<td>136.24</td>
</tr>
<tr>
<td>4.</td>
<td>Leaf moisture percentage</td>
<td>74.30</td>
<td>53.69</td>
<td>43.23</td>
</tr>
<tr>
<td>5.</td>
<td>Relative water content</td>
<td>44.63</td>
<td>36.24</td>
<td>22.03</td>
</tr>
</tbody>
</table>

Total Protein (mg/g):

Total protein observed in V1 leaves 96.33 compared to T1V1. The present of reduction in treated plants in 74 with 76% with T2V1 the total Protein in treated plants was 49 with 50% of decreasing in relative water content. In Mysore local which is rainfed variety the total Protein, the treated plants with T1ML in 53, 45 in T2ML with compared to 64 in controlled plants. So that percentage of reduction 82% and 70% respectively.
**Total Carbohydrate (mg/g):**

Total carbohydrate observed in V₁ leaves 12.06 compared to T1V1. The present of reduction in treated plants in 369.34 with 22% with T2V1 the total carbohydrate in treated plants was 7.06 with 41% of decreasing in total carbohydrate. In Mysore local which is rainfed variety the total carbohydrate, the treated plants T1ML in 9.64, 7.95 in T2ML with compared to 11.06 in controlled plants. So that percentage of reduction 12% and 28% respectively.

**Total Phenols (mg/g):**

Total phenols observed in V₁ leaves 2.86 compared to T1V1. The present of reduction in treated plants in 2.58 with 9.7% with T2V1 the total phenols in treated plants was 2.19 with 23% of decreasing in total phenols. In Mysore local which is rainfed variety the total phenols, the treated plants T1ML in 2.72, 2.51 in T2ML with compared to 2.93 in controlled plants. So that percentage of reduction 7.1% and 14% respectively.

**Total Chlorophyll (mg/g):**

Total chlorophyll observed in V₁ leaves 3.06 compared to T1V1. The present of reduction in treated plants in 2.59 with 15% with T2V1 the total chlorophyll in treated plants was 2.02 with 33% of decreasing in total chlorophyll. In Mysore local which is rainfed variety the total chlorophyll, the treated plants T1ML in 1.93, 1.68 in T2ML with compared to 2.53 in controlled plants. So that percentage of reduction 23% and 33% respectively.

**Table: 2 Primary metabolites of Mulberry (Victory-1 and Mysore local)**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Biochemical estimations</th>
<th>Victory-1 Control</th>
<th>5-days</th>
<th>7-days</th>
<th>Mysore local Control</th>
<th>5-days</th>
<th>7-days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Protein</td>
<td>96.33</td>
<td>74</td>
<td>49</td>
<td>64</td>
<td>53</td>
<td>45</td>
</tr>
<tr>
<td>2.</td>
<td>Total Carbohydrate</td>
<td>12.06</td>
<td>9.34</td>
<td>7.06</td>
<td>11.06</td>
<td>9.64</td>
<td>7.95</td>
</tr>
<tr>
<td>3.</td>
<td>Total Phenols</td>
<td>2.86</td>
<td>2.58</td>
<td>2.19</td>
<td>2.93</td>
<td>2.72</td>
<td>2.51</td>
</tr>
<tr>
<td>4.</td>
<td>Chlorophyll</td>
<td>3.06</td>
<td>2.59</td>
<td>2.02</td>
<td>2.53</td>
<td>1.93</td>
<td>1.68</td>
</tr>
</tbody>
</table>
SILKWORM BIOASSAY STUDIES:

**Observations:**

During rearing of silk worm significant changes were observed in both drought and control plants.

**Larval weight:**

In all the days of drought leaves fed larval weight was shown significant reductions in five days drought and seven days water schedule.

**3rd instar larval weight:**

In 3rd instar larval weight observed in V₁ leaves 4.55 compared to T1V1 the present of reduction 3.99 with 12.3% with T2V1 plants was 3.53 with 22.41% of decreasing. In Mysore local which is rainfed variety the treated plants T1ML in 3.68, 3.23 T2ML with compared to 4.6 in controlled plants. So that percentage of reduction 11.53% and 22.35% respectively.

**4th instar larval weight:**

In 4th instar larval weight observed in V₁ leaves 14.53 compared to T1V1 the present of reduction 11.49 with 20.92% with T2V1 plants was 39.73 with 33.03% of decreasing. In Mysore local which is rainfed variety the treated plants T1ML in 10.11, 7.56 T2ML with compared to 13.65 in controlled plants. So that percentage of reduction 25.93% and 44.61% respectively.
5th instar larval weight:
In 5th instar larval weight observed in V1 leaves 38.66 compared T1V1, the present of reduction 31.01 with 19.78% with T2V1 plants was 27.99 with 27.59% of decreasing. In Mysore local which is rainfed variety the treated plants T1ML in 29.66, 25.09 T2ML with compared to 35.98 in controlled plants. So that percentage of reduction 17.56% and 30.86% respectively.

Number of cocoons harvested:
Cocoons were harvested on the fifth day of moulting and the number of cocoons spun was recorded separately for control and drought larvae.
Number of cocoons harvested in V1 leaves 26 compared to T1V1 the present of reduction in treated plants in 20 with 23.07% with T2V1 was 17 with 34.61% of decreasing. In Mysore local which is rainfed variety the T1ML in 18, 15 in T2ML with compared to 22 in controlled plants. So that percentage of reduction 18.18% and 31.18% respectively.

Cocoon weight (g):
Cocoon weight in V1 leaves 15 compared to T1V1 the present of reduction in treated plants in 0.89 with 40.66% with T2V1 plants was 0.73 with 51.33% of decreasing. In Mysore local which is rainfed variety the T1ML in 0.79, 0.61 in T2ML with compared to 1.1 in controlled plants. So that percentage of reduction 28.18% and 44.54% respectively.

Cocoon shell weight (g):
Cocoon shell weight in V1 leaves 0.20 compared to T1V1 the present of reduction in treated plants in 0.15 with 28.57% with T2V1 was 0.11 with 47.61% of decreasing. In Mysore local which is rainfed variety the treated T1ML in 0.13, 0.10 in T2ML with compared to 0.18 in controlled plants. So that percentage of reduction 27.77% and 23.07% respectively.

Cocoon shell percentage (%):
Cocoon shell percentage weight in V1 leaves 23.52 compared to T1V1 the present of reduction in treated plants in 19.05 with 19% with T2V1 was 17.02 with 27.63% of decreasing. In Mysore local which is rainfed variety the treated T1ML in 18.06, 15.38 in T2ML with compared to 21.28 in controlled plants. So that percentage of reduction 15.13% and 27.72% respectively.
Reeling parameters:

**Total filament length (m):** Total filament length in V₁ leaves 1029.59 compared to T₁V₁ the present of reduction in treated plants in 897.3 with 12.84% with T₂V₁ was 763.24 with 25.86% of decreasing. In Mysore local which is rainfed variety the treated T₁ML in 796.23, 743.03 in T₂ML with compared to 1023.7 in controlled plants. So that percentage of reduction 22.22% and 27.41% respectively.

**Non breakable filament length (m):**
Non breakable filament length in V₁ leaves 345 compared to T₁V₁ the present of reduction in treated plants in 196 with 43.18% with T₂V₁ was 119 with 65.5% of decreasing. In Mysore local which is rainfed variety the treated T₁ML in 178, 144 in T₂ML with compared to 283 in controlled plants. So that percentage of reduction 37.1% and 49.11% respectively.

**Filament Denier:**
Filament Denier in V₁ leaves 2.2 compared to T₁V₁ the present of reduction in treated plants in 1.8 with 18.1% with T₂V₁ was 1.2 with 45.45% of decreasing. In Mysore local which is rainfed variety the treated T₁ML in 1.6, 1.4 in T₂ML with compared to 1.9 in controlled plants. So that percentage of reduction 15.78% and 26.31% respectively.

All the morphological and biochemical parameters were important for growth and development of silk worm and quality of cocoon production which indicated the nutrient values of mulberry leaf. It was considered that the quality of leaf derived by the presence of proteins, carbohydrates, chlorophylls.

Jalaja Kumar and Ram Rao (2008) analyzed leaf quality of seven mulberry genotypes and reported that total chlorophyll content was the highest in S-13 (3.35 mg/g fresh wt.), V-1 (3.24 mg/g fresh wt.) and V-4 (3.12 mg/g fresh wt.), while it was the lowest in S-36 2.55 mg/g fresh wt.). Jalaja Kumar and Ram Rao (2008) reported that among seven genotypes evaluated, total protein content was the highest in V-1 (24.56%) followed by S-36 (23.89%) and V-4 (22.67%).
Table 3: Larval weight of drought and control

<table>
<thead>
<tr>
<th>Mulberry variety</th>
<th>Type of larvae</th>
<th>V-1</th>
<th>Mysore local</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control 5 days</td>
<td>% of decrease</td>
<td>Control 5 days</td>
</tr>
<tr>
<td>Weight of larvae in 3rd instar</td>
<td>4.55</td>
<td>3.99</td>
<td>12.30</td>
</tr>
<tr>
<td>Weight of larvae in 4th instar</td>
<td>14.53</td>
<td>11.49</td>
<td>20.92</td>
</tr>
<tr>
<td>Weight of larvae in 5th instar</td>
<td>38.66</td>
<td>31.01</td>
<td>19.78</td>
</tr>
</tbody>
</table>

Table 4: Effect of Different Drought stress on Bioassay Parameters

<table>
<thead>
<tr>
<th>Mulberry variety</th>
<th>Parameters</th>
<th>V-1</th>
<th>Mysore local</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Control 5 days</td>
<td>% of decrease</td>
<td>Control 5 days</td>
</tr>
<tr>
<td>Number cocoons harvested</td>
<td>26</td>
<td>20</td>
<td>23.07</td>
</tr>
<tr>
<td>Cocoon weight (g)</td>
<td>1.5</td>
<td>0.89</td>
<td>40.66</td>
</tr>
<tr>
<td>Cocoon shell weight (g)</td>
<td>0.20</td>
<td>0.15</td>
<td>28.57</td>
</tr>
<tr>
<td>Cocoon shell percentage (%)</td>
<td>23.52</td>
<td>19.05</td>
<td>19</td>
</tr>
<tr>
<td>Total filament length (cm)</td>
<td>1029.59</td>
<td>897.3</td>
<td>12.84</td>
</tr>
<tr>
<td>Non breakable filament length</td>
<td>345</td>
<td>196</td>
<td>43.18</td>
</tr>
<tr>
<td>Filament Denier</td>
<td>2.2</td>
<td>1.8</td>
<td>18.18</td>
</tr>
</tbody>
</table>
V1 Control plants

Mysore local Control plants

V1 five days’ plants

Mysore local five days’ plants

<table>
<thead>
<tr>
<th>Number cocoons harvested</th>
<th>Cocoon weight (g)</th>
<th>Cocoon shell weight (g)</th>
<th>Cocoon shell percentage (%)</th>
<th>Total filament length (cm)</th>
<th>Non breakable filament length</th>
<th>Filament Denier</th>
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<tr>
<td>Control</td>
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<td>5 days</td>
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<td>7 days</td>
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<tr>
<td>V-1</td>
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<tr>
<td>Mysore local</td>
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<tr>
<td>5 days</td>
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<tr>
<td>7 days</td>
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CONCLUSION

The silk cocoon yield mainly depends on silk worm rearing management and the quality of mulberry leaves. If silkworm rearing and cocoon production are to be a success, it is very necessary that mulberry leaf to be fed to the silkworms is very nutritive and fresh. The cultivation of mulberry for raising silkworm cocoon crops mainly aims not only at increased production of leaves per unit area but also leaves of suitable quality for the maximum utilization of the leaf crop produced. It has been fairly well recognized that both chemical composition and nutritive value of the leaves as reflected in the silkworm cocoon crop differ considerable from variety to variety, season to season or according to growth and maturity of the leaves, manure application, irrigation and so on.

The present study is conformably in finding of different scientists who have conducted experiments on different plant species including mulberry imposed with drought conditions they were follows Narayanan et al., (1966) and Sidhu et al., (1969) have reported about the quality differences in leaves due to variety, irrigation and maturing. Mulberry improvement is also aimed at bringing qualitative improvement of leaves and a survey of the available literature reveals that extensive studies have been carried out on the varietal response, effect of agronomical inputs, seasons and related aspects on biochemical composition of leaves. Chaluvachari and Bongale (1995) discussed the importance of quality of mulberry leaves used as feed
for silkworm. High quantity of chlorophyll ‘a’ and ‘b’ is advantageous since they are the most important pigment in photosynthesis. Carbohydrates of the mulberry leaves are synthesized by the photosynthetic action of the leaves. Carbohydrates particularly the sugar content in mulberry leaves in closely related to the health of the silkworm. Mulberry leaves with high sugar content fields good results of rearing. Moreover by adding sugar artificially to the feed, the occurrence of flacherie was reported to have greatly reduced. (Kichisaburo minamizawa, 1970).

ACKNOWLEDGMENT

The author thank full to the department of Sericulture, Sri Padmavati Mahila University, Tirapati. Consider to the great guidance of my research supervisor for this work and thank full to the University for providing facilities doing this work.

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