



STUDIES ON THE SUITABILITY OF ELITE MULBERRY VARIETIES AT DIFFERENT ALTITUDES OF UTTARAKHAND

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ABSTRACT

Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area has a direct bearing on cocoon harvest, although various highly productive mulberry varieties and appropriate cultivation packages have been developed to produce a high quantum of quality leaf. Data recorded on Bio-chemical analysis viz. Total Soluble Carbohydrate (TSC) (mg/g dwt) Total Soluble Protein (TSP)(mg/g dwt) and Total Chlorophyll Content (TCC) (mg/g dwt) at all 03 sites and Bioassay studies show that 02 mulberry varieties i.e. S-140 (PPR-1) and Tr-10 were found superior to other varieties including S-146, which was taken as control under this experiment.

KEY WORDS: *Mulberry Varieties, Silkworm rearing, Biochemical analysis, Bioassay.*

INTRODUCTION

Sericulture in India is of ancient origin, dating back prior to the inception of Christian era. Sericulture industry today is very well established agro based cotton industry providing employment to more than 6 million people of approximately 50,000 villages of the country with diversified socio economic background. This industry till recently was mostly being popularised in the states of Karnataka, Andhra Pradesh, Tamil Nadu, Jammu & Kashmir and West Bengal, even though the potential of sericulture lied in other regions as well. Hills and foot hills of Doon valley are ideal place for silk production. In this state sericulture was introduced on forest mulberry plantation at Lucknow as early as 1847 by Capital Holing but did not progress well. It was in the year 1858 that Capt. Hutton took a keen interest to restart mulberry sericulture by conducting breeding experiment on mulberry silkworm, consequently ReshamMajri village in eastern part of Dehradun was designated as model sericulture village and State Govt. initiated to develop this industry by establishing a mulberry farm at Doiwala village of Doon valley in the year 1948- 49. The survey of sericultural belt reveals that sericulture sustains mainly on the mulberry trees in North West India. Doon Valley is considered as most suitable for bivoltine cocoon production in Uttarakhand State. The cocoon production of this area is about one lakh kg per year and declining periodically due to pressure of rapid industrialization and urbanization of area resulting in reduction of cultivated land area, Hence, farmers are bound to utilize mulberry leaves from trees growing naturally or cultivated in forest area, roads and along bunds of field etc. Therefore, it is urgent need to develop a schedule for silkworm



rearing on tree mode of cultivation. Presently spring crop is with an average yield of 31.89 Kg. /100 DFLs and autumn crop average yield is 21.25 Kg. /100 DFLs. To make sericulture more sustainable autumn crop productivity has to be enhanced. Govindan, *et al* (1987).

MATERIALS & METHODS

- The experiment was conducted during the experimental period in 04 season's viz., spring-2019, autumn - 2019, spring -2020 and autumn- 2020 at the mulberry farm of Regional Sericultural Research Station, Sahaspur, Dehradun and selected sites in Uttarakhand.
- Soil samples from experimental plantation sites were collected and analysis of soil was done for pH, organic carbon and NPK at CSR&TI, Pampore during 2019.
- Nursery of 06 mulberry varieties viz. S-1635, T.R.-10, S-140, Vishala, T.R.-23 and S-146 (as control) was raised.
- Plantation of 06 mulberry varieties as treatments viz.S-1635, T.R.-10, S-140, Vishala, T.R.-23 and S-146 (as control) was raised at R.S.R.S., Sahaspur and at different altitudes of hills in Uttarakhand.
- The data on the survival during October 2018 and March, 2019 at all sites and various growth parameters was recorded after 90 days, 180 days and 360 days.
- The saplings of the said six mulberry varieties were transplanted and raised the plantation at 04 study sites viz. RSRS, Sahaspur, DOS Farm, Srinagar, DOS Farm, Bageshwar and DOS farm Almora during the month of September, 2018. The plantation was maintained as per the package of practices. However, DoS, Srinagar, in a policy decision of the state Govt. was handed over to NIT, Campus and hence the Srinagar site was dropped from the experiment and data were recorded from only 03 sites. The survivability%, of the plantation at different sites was recorded during the month of March, 2019. Data on morphological characters viz. shoot length, inter nodal distance, fresh weight of 100 leaves, leaf yield per plant and biochemical analysis was recorded. Moisture% and moisture retention capacity after 12 hours during spring and autumn 2020 was recorded.
- The bioassay studies of the six mulberry varieties at RSRS, Sahaspur was conducted during spring and autumn -2020.
- Cocoon samples was got tested for technological parameters during spring and autumn 2020 in all the 06 mulberry varieties.

The experimental details are as under:-

- Name of mulberry variety: S1635, TR-10, S-140, Vishala, TR-23 & S146 (Control)
- No of plants/Localities: 10 in three replication
- Training: Tree (Crown 5.5- 6.0 feet)
- Spacing: 8' x 8' feet
- Design: RBD
- Size of the pit: 2' x 2' x 2'
- Ratio of Mixture: 3: 2:1

After the establishment period the growth observations were taken as per the standard recommendations, normal standard recommended package of practices. Bioassay was also conducted to evaluate the nutritive value of the mulberry wealth in term of quality of raw silk. The Post-Cocoon parameters s for both seasons were also tested.

**RESULTS & DISCUSSION**

1- Variety wise survivability% of mulberry plantation raised at different sites in Uttarakhand: Data recorded on survivability% is presented as under:

| Varieties | No. of plants raised at each site | No. of Plants Survived and survivability | | | | | | | |
|-----------|-----------------------------------|--|---------------|-------------------------|---------------|------------------------|---------------|------------------------|---------------|
| | | RSRS, Sahaspur | | DOS Farm, Srinagar | | DOS Farm, Garur | | DOS Farm, Sironia | |
| | | No. of plants survived | Survivability | No. of plants survived. | Survivability | No. of plants survived | Survivability | No. of plants survived | Survivability |
| S-1635 | 36 | 32 | 88.88 | 29 | 80.55 | 34 | 94.44 | 35 | 97.22 |
| Tr-10 | 36 | 32 | 88.88 | 26 | 72.22 | 34 | 94.44 | 30 | 83.33 |
| S-140 | 36 | 31 | 86.11 | 22 | 61.11 | 29 | 80.55 | 36 | 100.00 |
| Vishala | 36 | 31 | 86.11 | 26 | 72.22 | 35 | 97.22 | 29 | 80.55 |
| Tr-23 | 36 | 32 | 88.88 | 29 | 80.55 | 35 | 97.22 | 34 | 94.44 |
| S-146 | 36 | 35 | 97.22 | 26 | 72.22 | 30 | 83.33 | 30 | 83.33 |

Survivability% ranges from 61 to 97.22% at all sites and in all the varieties.

Note: In the meantime a part of DoS Farm, Srinagar was handed over to NIT, in a policy decision of the government and entire portion in which, 06 mulberry varieties were planted under this experiment was transferred to NIT campus. As such this site was dropped, henceforth under this experiment and further observations and recording of data were made at 03 sites only, i.e. RSRS, Sahaspur, SDD, Bageshwar and SDD, Almora.

2- Growth Parameters of 06 mulberry varieties: Growth parameters during spring-2019 at 03 locations are presented as under:

Study site: RSRS, Sahaspur, Dehradun: Season; Spring, 2019.

| Variety | Shoot Length (cm) | Inter-nodal distance | fresh weight of 100 leaves (g) | Leaf yield per plant (gm) | Moisture % | Moisture Retention Capacity (%) 12 hours |
|--------------|-------------------|----------------------|--------------------------------|---------------------------|--------------|--|
| Tr-10 | 170.25 | 4.10 | 133.75 | 173.75 | 73.30 | 61.95 |
| S-140 | 165.25 | 4.80 | 140.00 | 182.50 | 69.84 | 65.42 |
| S-1635 | 185.00 | 4.38 | 125.00 | 179.25 | 68.79 | 64.68 |
| Vishala | 189.75 | 5.43 | 119.50 | 174.25 | 72.17 | 66.27 |
| Tr-23 | 178.00 | 4.34 | 123.75 | 176.25 | 72.26 | 64.23 |
| S-146 | 174.25 | 4.75 | 122.00 | 164.75 | 69.73 | 63.93 |
| C.D. | N/A | N/A | N/A | N/A | 2.682 | 1.826 |
| SE(m) | 6.525 | 0.306 | 5.827 | 5.946 | 0.882 | 0.600 |
| SE(d) | 9.227 | 0.433 | 8.241 | 8.409 | 1.247 | 0.849 |
| C.V. | 7.369 | 13.209 | 9.153 | 6.791 | 2.483 | 1.864 |

The role of Moisture% and Moisture Retention Capacity% in leaf play significant role in successful silkworm rearing and during spring season-2019 all 06 mulberry varieties were found good on these 02 parameters.



Study site: SDD, Gurur, Bageshwar:
Season: Spring, 2019.

| Variety | Shoot Length (cm) | No. of Branches | Inter-nodal distance | fresh weight of 100 leaves (g) | Leaf yield per plant (g) | Moisture % | Moisture Retention Capacity (%) |
|---------|-------------------|-----------------|----------------------|--------------------------------|--------------------------|------------|---------------------------------|
| Tr-10 | 152.50 | 13.75 | 4.18 | 106.05 | 166.41 | 70.27 | 67.93 |
| S-140 | 155.00 | 17.00 | 5.16 | 99.99 | 131.25 | 73.13 | 65.37 |
| S-1635 | 169.00 | 18.00 | 4.83 | 115.91 | 146.80 | 70.38 | 62.34 |
| Vishala | 151.25 | 15.75 | 4.45 | 137.68 | 186.52 | 73.14 | 69.56 |
| Tr-23 | 144.75 | 17.50 | 4.88 | 120.45 | 144.78 | 76.86 | 60.85 |
| S-146 | 150.00 | 11.75 | 5.44 | 95.26 | 90.47 | 71.42 | 69.17 |
| C.D. | N/A | 3.288 | 0.789 | N/A | 44.855 | 2.859 | 3.466 |
| SE(m) | 17.767 | 1.081 | 0.259 | 16.076 | 14.746 | 0.940 | 1.140 |
| SE(d) | 25.127 | 1.529 | 0.367 | 22.735 | 20.854 | 1.329 | 1.612 |
| C.V. | 23.131 | 13.838 | 10.759 | 28.565 | 20.428 | 2.622 | 3.512 |

Moisture% and Moisture Retention Capacity in leaf% was found good at Bageshwar and Almorah site also in all 06 mulberry varieties selected under this experiment.

Study site: SDD, Sironia, Almora: Season: Spring, 2019

| Variety | Shoot Length (cm) | No. of Branches | Inter-nodal distance | fresh weight of 100 leaves (g) | Leaf yield per plant (g) | Moisture % | Moisture Retention Capacity (%) |
|---------|-------------------|-----------------|----------------------|--------------------------------|--------------------------|------------|---------------------------------|
| Tr-10 | 155.00 | 16.75 | 4.58 | 131.79 | 157.79 | 67.78 | 64.64 |
| S-140 | 181.25 | 21.75 | 5.00 | 122.05 | 171.40 | 70.38 | 62.78 |
| S-1635 | 170.00 | 18.25 | 4.88 | 119.55 | 159.55 | 73.65 | 61.89 |
| Vishala | 142.50 | 12.50 | 5.01 | 123.95 | 194.20 | 69.07 | 63.14 |
| Tr-23 | 144.25 | 15.50 | 4.50 | 118.67 | 144.10 | 78.29 | 64.36 |
| S-146 | 158.75 | 11.50 | 4.60 | 119.76 | 146.39 | 69.74 | 63.92 |
| C.D. | N/A | N/A | N/A | N/A | N/A | 5.689 | N/A |
| SE(m) | 23.783 | 2.301 | 0.394 | 8.668 | 13.437 | 1.870 | 2.044 |
| SE(d) | 33.634 | 3.255 | 0.558 | 12.258 | 19.003 | 2.645 | 2.891 |
| C.V. | 29.986 | 28.693 | 16.558 | 14.137 | 16.565 | 5.233 | 6.444 |

Growth Parameters of 06 mulberry varieties during autumn, 2019: Growth Parameters recorded during autumn-2019 at all 03 sites are presented as under:



[Study site: RSRS, Sahaspur]:

| Variety | No. of branches | Shoot length (cm) | Internodal distance | Weight of 100 leaves (gm) | Leaf weight per plant (gm) | Moisture (%) | Moisture retention capacity (%) |
|---------|-----------------|-------------------|---------------------|---------------------------|----------------------------|---------------|---------------------------------|
| Tr-10 | 12.35 | 190 | 4.65 | 108.00 | 314.00 | 76.395 | 62.765 |
| S-140 | 5.50 | 175 | 5.30 | 153.50 | 210.25 | 75.486 | 61.718 |
| S-1635 | 8.60 | 200.20 | 4.73 | 113.50 | 208.75 | 64.748 | 61.403 |
| Vishala | 7.00 | 208.00 | 5.05 | 150.00 | 257.50 | 74.363 | 60.418 |
| Tr-23 | 7.60 | 185 | 4.25 | 96.00 | 218.75 | 74.825 | 61.671 |
| S-146 | 10.35 | 205.95 | 3.98 | 107.00 | 348.75 | 75.098 | 62.931 |
| C.D. | 2.947 | 13.835 | 0.837 | 36.638 | N/A | 18.213 | N/A |
| SE(m) | 0.969 | 4.548 | 0.275 | 12.045 | 49.278 | 5.988 | 3.184 |
| SE(d) | 1.370 | 6.432 | 0.389 | 17.034 | 69.690 | 8.468 | 4.503 |
| C.V. | 22.615 | 4.844 | 11.812 | 19.759 | 37.955 | 16.860 | 10.098 |

3- Growth Parameters of 06 mulberry varieties during autumn, 2019-

Study site: SDD, Gurur, Bageshwar:

| Variety | No. of branches | Shoot length (cm) | Inter nodal distance | Fresh weight of 100 leaves (gm) | Leaf yield per plant (gm) | Moisture (%) | Moisture Retention Capacity (%) after 12 hours |
|---------|-----------------|-------------------|----------------------|---------------------------------|---------------------------|--------------|--|
| S-1635 | 11.75 | 164.83 | 4.44 | 208 | 334.50 | 72.971 | 60.699 |
| TR-10 | 14.25 | 165.58 | 3.81 | 164 | 330.00 | 71.000 | 60.633 |
| S-140 | 11.25 | 163.08 | 5.10 | 268 | 352.00 | 75.447 | 61.494 |
| Tr-23 | 12.50 | 149.53 | 4.41 | 160 | 212.00 | 72.712 | 60.256 |
| S146 | 10.75 | 154.30 | 5.42 | 172 | 340.00 | 71.086 | 58.855 |
| Vishala | 14.00 | 152.23 | 4.53 | 316 | 580.00 | 73.472 | 62.166 |
| C.D. | N/A | N/A | 0.537 | 74.751 | 154.966 | N/A | N/A |
| SE(m) | 1.233 | 17.699 | 0.177 | 24.575 | 50.945 | 2.759 | 1.289 |
| SE(d) | 1.743 | 25.030 | 0.250 | 34.754 | 72.047 | 3.902 | 1.823 |
| C.V. | 19.855 | 22.368 | 7.647 | 22.967 | 28.454 | 7.724 | 4.276 |

5. Growth Parameters of 06 mulberry varieties during autumn, 2019-

Study site: SDD, Sironia, Almora:

| Variety | No. of branches | Shoot length (cm) | Inter Nodal Distance | Fresh weight of 100 leaves (g) | Leaf yield per plant (g) | Moisture (%) | Moisture Retention Capacity (%) after 12 hours |
|---------|-----------------|-------------------|----------------------|--------------------------------|--------------------------|--------------|--|
| Tr-10 | 16.00 | 158.25 | 4.48 | 440 | 896.00 | 76.92 | 60.93 |
| S-140 | 14.50 | 179.98 | 4.68 | 412 | 720.00 | 76.11 | 62.27 |
| S-1635 | 14.50 | 193.65 | 4.53 | 372 | 740.00 | 74.91 | 60.95 |
| Vishala | 12.75 | 106.60 | 6.25 | 464 | 990.00 | 78.03 | 61.82 |
| Tr-23 | 15.75 | 188.18 | 4.68 | 412 | 745.00 | 75.61 | 61.57 |
| S-146 | 15.00 | 117.60 | 5.20 | 340 | 685.00 | 74.29 | 60.32 |
| C.D. | N/A | N/A | N/A | N/A | N/A | 5.689 | N/A |



| Variety | No. of branches | Shoot length (cm) | Inter Nodal Distance | Fresh weight of 100 leaves (g) | Leaf yield per plant (g) | Moisture (%) | Moisture Retention Capacity (%) after 12 hours |
|---------|-----------------|-------------------|----------------------|--------------------------------|--------------------------|--------------|--|
| SE(m) | 23.783 | 2.301 | 0.394 | 8.668 | 13.437 | 1.870 | 2.044 |
| SE(d) | 33.634 | 3.255 | 0.558 | 12.258 | 19.003 | 2.645 | 2.891 |
| C.V. | 29.986 | 28.693 | 16.558 | 14.137 | 16.565 | 5.233 | 6.444 |

The data recorded on growth parameters during autumn season-2019 also show that all 06 mulberry varieties were having good Moisture% and Moisture Retention Capacity% at all 03 sites viz: Sahaspur, Almorah and Bageshwar.

6. Biochemical analysis of different varieties of mulberry leaf at different altitudes during autumn, 2019. (Mean Values)

Study site: RSRS, Sahaspur

| Sl.No | Mulberry Variety | Total Soluble Carbohydrate (TSC) (mg/g dwt) | Total Soluble Protein (TSP) (mg/g dwt) | Total Chlorophyll Content (TCC) (mg/g dwt) |
|--------------------|------------------|---|--|--|
| V1 | S-1635 | 240.58 | 49.07 | 3.82 |
| V2 | Tr-10 | 291.44 | 43.70 | 5.82 |
| V3 | S-140 | 277.10 | 49.67 | 4.85 |
| V4 | Vishala | 157.45 | 32.66 | 2.84 |
| V5 | Tr-23 | 239.28 | 50.12 | 3.85 |
| V6 | S-146 | 236.02 | 39.24 | 3.89 |
| Total | | 1441.87 | 264.46 | 25.07 |
| Mean values | | 240.31 | 44.08 | 4.18 |

Data recorded on Biochemical analysis during-autumn-2019 reveal that at Sahaspur, Dehradun site, Total Soluble Carbohydrate (TSC) i.e. 291.44 mg/g dwt, was found maximum in Tr-10 followed by S-140 i.e. 277.44 mg/g dwt and superior to control i.e. 236.02 mg/g dwt in S-146. Total Soluble Protein (TSP) was found maximum in Tr-23 (50.12), followed by S-140 (49.67) and superior to control i.e. 39.24 in S-146, and Total Chlorophyll Content (TCC) was found maximum i.e. 5.82 in Tr-10 followed by 4.85 mg/g dwt in S-140 (PPR-1) was also superior to control i.e. 3.89 in S-146.

Study site: DOS, Bageshwar: The data recorded are presented as under:

| Sl.No | Mulberry Variety | Total Soluble Carbohydrate (TSC) (mg/g dwt) | Total Soluble Protein (TSP) (mg/g dwt) | Total Chlorophyll Content (TCC) (mg/g dwt) |
|--------------------|------------------|---|--|--|
| V1 | S-1635 | 210.92 | 32.21 | 3.11 |
| V2 | Tr-10 | 311.00 | 43.35 | 5.39 |
| V3 | S-140 | 292.74 | 44.75 | 4.32 |
| V4 | Vishala | 155.17 | 27.64 | 2.60 |
| V5 | Tr-23 | 187.77 | 30.25 | 3.45 |
| V6 | S-146 | 228.85 | 28.20 | 3.62 |
| Total | | 1386.45 | 206.4 | 22.49 |
| Mean values | | 231.08 | 34.40 | 3.75 |

Data recorded on Biochemical analysis during-autumn-2019 reveal that at Bageshwar site Total Soluble Carbohydrate (TSC) i.e. 311.00 mg/g dwt, was found maximum in Tr-10 followed by S-140 i.e. 292.74 mg/g dwt.



Total Soluble Protein (TSP) and Total Chlorophyll Content (TCC) were also found maximum i.e. 44.75 and 4.32 and 43.35 and 5.39 mg/g/dwt, respectively, in S-140 and Tr.10, which was superior to control i.e. S-146, on all aspects.

Study site: DOS, Almora-

| Sl.No | Mulberry Variety | Total Soluble Carbohydrate (TSC) (mg/g dwt) | Total Soluble Protein (TSP) (mg/g dwt) | Total Chlorophyll Content (TCC) (mg/g dwt) |
|--------------------|------------------|---|--|--|
| V1 | S-1635 | 123.22 | 30.05 | 2.78 |
| V2 | Tr-10 | 325.34 | 44.86 | 5.19 |
| V3 | S-140 | 332.19 | 37.28 | 4.25 |
| V4 | Vishala | 107.90 | 20.42 | 2.29 |
| V5 | Tr-23 | 159.08 | 30.25 | 2.04 |
| V6 | S-146 | 211.90 | 23.73 | 3.26 |
| Total | | 1259.63 | 186.59 | 19.81 |
| Mean values | | 209.94 | 31.10 | 3.30 |

Data recorded on Biochemical analysis during-autumn-2019 reveal that at Almora site Total Soluble Carbohydrate (TSC) i.e. 332.19 mg/g dwt, was found maximum in followed by Tr.10 i.e. 325.34 mg/g dwt. Total Soluble Protein (TSP) and Total Chlorophyll Content (TCC) were also found maximum i.e. 44.86 and 5.19 and 37.28 and 4.25 mg/g/dwt, respectively, in Tr.10 and S-140 and was superior to control i.e. S-146.

7. Data recorded on TSC, TSP and TCC at different sites are summarized as under:

| Variety | Total Soluble Carbohydrate (TSC) (mg/g dwt) | | | Total Soluble Protein (TSP) (mg/g dwt) | | | Total Chlorophyll Content (TCC) (mg/g dwt) | | |
|--------------|---|----------------|----------------|--|--------------|---------------|--|--------------|--------------|
| | Sahaspur | Bageshwar | Almorah | Sahaspur | Bageshwar | Almorah | Sahaspur | Bageshwar | Almorah |
| S-1635 | 240.58 | 210.92 | 123.22 | 49.07 | 32.21 | 30.05 | 3.82 | 3.11 | 2.78 |
| Tr-10 | 291.44 | 311.00 | 325.34 | 43.70 | 43.35 | 44.86 | 5.82 | 5.39 | 5.19 |
| S-140 | 277.10 | 292.74 | 332.19 | 49.67 | 44.75 | 37.28 | 4.85 | 4.32 | 4.25 |
| Vishala | 157.45 | 155.17 | 107.90 | 32.66 | 27.64 | 20.42 | 2.84 | 2.60 | 2.29 |
| Tr-23 | 239.28 | 187.77 | 159.08 | 50.12 | 30.25 | 30.25 | 3.85 | 3.45 | 2.04 |
| S-146 | 236.02 | 228.85 | 211.90 | 39.24 | 28.20 | 23.73 | 3.89 | 3.62 | 3.26 |
| Total | 1441.87 | 1386.45 | 1259.63 | 264.46 | 206.4 | 186.59 | 25.07 | 22.49 | 19.81 |
| Mean | 240.31 | 231.08 | 209.94 | 44.08 | 34.40 | 31.10 | 4.18 | 3.75 | 3.30 |

8- Results of the soil samples analysis: (2019): Data on soil samples analysis, presented as under, show that there is no major nutritional deficiency was observed, in all these 03 sites, selected under this experiment.

| parameters | RSRS, Sahaspur | | Sironia, Almora | | Garur, Bageshwar | |
|---------------------|----------------|-----------------|-----------------|---------------------|------------------|------------|
| | Test Values | Rating | Test Values | Rating | Test Values | Rating |
| pH | 6.48 | Slightly acidic | 7.15 | Moderately alkaline | 6.59 | Normal |
| EC (ds/m) | 0.04 | Normal | 0.41 | Normal | 0.28 | Medium |
| OC (%) | 0.89 | High | 1.06 | High | 0.58 | Low |
| Available N (kg/ha) | 341.10 | Medium | 480.00 | Medium | 290 | Medium |
| Available P (kg/ha) | 162.20 | Very High | 66.00 | High | 88 | Medium |
| Available K (kg/ha) | 74.81 | Low | 251.00 | Medium | 157 | Sufficient |
| Available S (ppm) | 6.00 | Deficient | 19.00 | Sufficient | 14 | Sufficient |
| Available Zn (ppm) | 2.29 | Sufficient | 2.20 | Sufficient | 1.66 | Sufficient |



| | | | | | | |
|--------------------|-------|------------|-------|------------|-------|------------|
| Available B (ppm) | 0.47 | Deficient | 2.70 | Sufficient | 2.76 | Sufficient |
| Available Fe (ppm) | 30.20 | Sufficient | 22.50 | Sufficient | 20.30 | Sufficient |
| Available Mn (ppm) | 1.08 | Deficient | 5.50 | Sufficient | 11.50 | Sufficient |
| Available Cu (ppm) | 3.18 | Sufficient | 2.30 | Sufficient | 2.80 | Sufficient |

9- **Moisture% & MRC (%) Spring 2020: (RSRS, Sahaspur)** The data recorded on growth parameters during spring and autumn season-2020 also show that all 06 mulberry varieties were having good moisture% and moisture retention capacity% and presented as under:

| Variety | FRESH WT. OF 25 LEAVES | WT. AFTER 12 HRS | DRY WEIGHT | MOISTURE % | MRC AFTER 12 HRS |
|---------------|------------------------|------------------|--------------|--------------|------------------|
| Tr-10 | 141 | 130 | 039 | 72.43 | 60.48 |
| TR-23 | 136 | 127 | 039 | 71.18 | 60.13 |
| PPR-1 (S-140) | 232 | 216 | 058 | 74.90 | 62.03 |
| S-1635 | 133 | 120 | 035 | 74.00 | 60.52 |
| S-146 | 138 | 125 | 037 | 73.18 | 60.06 |
| Vishala | 146 | 135 | 039 | 73.13 | 61.66 |
| C.D. | 0.011 | 0.012 | 0.004 | 1.126 | 1.082 |
| SE(m) | 0.004 | 0.004 | 0.001 | 0.353 | 0.339 |
| SE(d) | 0.005 | 0.005 | 0.002 | 0.499 | 0.479 |
| C.V. | 3.935 | 4.618 | 5.710 | 0.836 | 0.966 |

10- **Moisture% & MRC (%) Autumn 2020: (RSRS, Sahaspur)**

| Variety | Wt. of 25 leaves (g) | Wt. after 12 hours (g) | Dry Weight (g) | Moisture % | MRC after 12 Hours (%) |
|---------------|----------------------|------------------------|----------------|--------------|------------------------|
| Tr-10 | 145 | 134 | 040 | 72.45 | 60.58 |
| Tr-23 | 173 | 162 | 049 | 71.47 | 60.35 |
| PPR-1 (S-140) | 254 | 241 | 065 | 74.55 | 63.09 |
| S-1635 | 164 | 154 | 045 | 72.30 | 61.66 |
| S-146 | 149 | 139 | 043 | 71.39 | 60.60 |
| Vishala | 151 | 143 | 043 | 71.65 | 61.26 |
| C.D. | 0.042 | 0.041 | 0.012 | 1.145 | 1.227 |
| SE(m) | 0.013 | 0.013 | 0.004 | 0.359 | 0.384 |
| SE(d) | 0.019 | 0.018 | 0.005 | 0.507 | 0.544 |
| C.V. | 13.211 | 13.654 | 13.928 | 0.859 | 1.087 |

11- **Moulting % during Spring, 2020(RSRS, Sahaspur)**

| Variety | 1st moult | 2nd moult | 3rd moult |
|---------------|--------------|--------------|--------------|
| S-1635 | 98.67 | 99.19 | 99.46 |
| Tr-10 | 99.33 | 99.19 | 99.46 |
| PPR-1 (S-140) | 99.07 | 99.60 | 99.87 |
| Vishala | 98.00 | 99.18 | 99.45 |
| Tr-23 | 98.27 | 99.19 | 99.59 |
| S-146 | 97.73 | 98.77 | 99.31 |
| C.D. | 0.536 | 0.419 | N/A |
| SE(m) | 0.168 | 0.131 | 0.133 |
| SE(d) | 0.237 | 0.185 | 0.188 |
| C.V. | 0.295 | 0.229 | 0.231 |



Moulting % was also more than 90% in all the varieties. The statistical analysis of the data also reveals that it was found statistically significant on this parameter.

12- Bioassay studies during Spring 2020, at R.S.R.S. Sahaspur:

| Variety | Fec. | Hat. % | Larval duration (D:H) | Wt. of 10 mature larvae | Yield/10000 Larvae | | SCW (g) | SSW (g) | SR % |
|---------------|--------|--------|-----------------------|-------------------------|--------------------|---------------|--------------|--------------|--------------|
| | | | | | By Wt. (kg) | By No. | | | |
| S-1635 | 487.0 | 96.67 | 24.00 | 50.00 | 13.150 | 9786.00 | 1.74 | 0.35 | 20.11 |
| Tr-10 | 482.00 | 97.33 | 24.00 | 45.00 | 13.260 | 9800.00 | 1.76 | 0.36 | 20.45 |
| S-140 (PPR-1) | 476.00 | 98.00 | 23.12 | 43.33 | 14.067 | 9720.0 | 1.72 | 0.36 | 20.93 |
| Vishala | 469.00 | 95.67 | 23.06 | 42.00 | 12.900 | 9906.00 | 1.78 | 0.35 | 19.66 |
| Tr-23 | 480.00 | 96.67 | 23.06 | 48.00 | 12.860 | 9773.00 | 1.73 | 0.33 | 19.08 |
| S-146 | 474.00 | 98.00 | 23.00 | 42.00 | 13.200 | 9800.00 | 1.66 | 0.33 | 19.88 |
| C.D. | | | | | 0.616 | 64.866 | 0.022 | 0.019 | 0.890 |
| SE(m) | | | | | 0.193 | 20.323 | 0.007 | 0.006 | 0.279 |
| SE(d) | | | | | 0.273 | 28.741 | 0.010 | 0.008 | 0.394 |
| C.V. | | | | | 2.526 | 0.359 | 0.680 | 2.980 | 2.413 |

Bioassay studies during spring-2020- Bioassay data reveal that yield/10000 larvae by wt. (kg) was found maximum in S-140 mulberry variety i.e. 14.067 kg. The single cocoon wt., Single shell wt. and S/R %, 1.720(g), 0.360(g) and 20.93%, respectively, were also recorded maximum in S-140 followed by Tr-10 with yield/10000 larvae by wt. (kg) the Single Cocoon wt., Single shell wt. and S/R %, as 13.260, 1.76, 0.36 and 20.45, respectively. Statistical analysis of the data reveals that it was found statistically significant on parameters such as Yield/10000 larvae (By Wt. kg), SCW (g), SSW (g) and S/R%. The statistical analysis of the data also reveals that it was found significant on all these parameters to control i.e. S-146.

13- Moulting test during autumn 2020:

| Variety | 1 st moult | 2 nd moult | 3 rd moult |
|--------------|-----------------------|-----------------------|-----------------------|
| Tr-10 | 97.33 | 97.00 | 97.56 |
| PPR-1(S-140) | 97.56 | 96.89 | 97.78 |
| S-1635 | 97.33 | 96.89 | 97.11 |
| Vishala | 97.33 | 96.33 | 96.89 |
| Tr-23 | 97.11 | 95.89 | 96.78 |
| S146 | 97.22 | 96.44 | 96.89 |
| C.D. | <i>N/A</i> | 0.635 | 0.361 |
| SE(m) | 0.162 | 0.199 | 0.113 |
| SE(d) | 0.229 | 0.281 | 0.160 |
| C.V. | 0.288 | 0.357 | 0.202 |

**14 Bioassay studies during autumn 2020, at R.S.R.S., Sahaspur:**

| Variety | Fecundity | Hatching % | Larval duration (D:H) | Wt. of 10 mature larvae | Yield/10000 Larvae | | SCW (g) | SSW (g) | SR % |
|---------------|-----------|------------|-----------------------|-------------------------|--------------------|---------------|--------------|--------------|--------------|
| | | | | | By Wt. (kg) | By No. | | | |
| S-1635 | 475.3 | 96.30 | 23.00 | 38.0 | 11.50 | 7830.0 | 1.61 | 0.320 | 19.88 |
| Tr-10 | 373.33 | 95.33 | 23.00 | 37.00 | 12.07 | 8023.33 | 1.59 | 0.317 | 20.13 |
| S-140 (PPR-1) | 481.00 | 95.67 | 23.06 | 37.67 | 11.73 | 7961.67 | 1.57 | 0.320 | 20.38 |
| Vishala | 485.67 | 95.67 | 23.06 | 37.33 | 11.43 | 7738.33 | 1.59 | 0.300 | 18.87 |
| Tr-23 | 475.33 | 95.67 | 23.06 | 37.33 | 11.41 | 7863.33 | 1.58 | 0.310 | 19.62 |
| S-146 | 482.00 | 95.67 | 23.00 | 37.33 | 10.69 | 7436.67 | 1.55 | 0.293 | 18.90 |
| C.D. | | | | | 0.487 | 92.164 | 0.028 | 0.017 | 0.770 |
| SE(m) | | | | | 0.153 | 28.876 | 0.009 | 0.005 | 0.241 |
| SE(d) | | | | | 0.216 | 40.836 | 0.012 | 0.008 | 0.341 |
| C.V. | | | | | 2.306 | 0.640 | 0.957 | 3.061 | 2.133 |

Bioassay studies during autumn-2019- Bioassay data reveal that yield/10000 larvae by wt. (kg) was found maximum in Tr-10 mulberry variety i.e. 12.07 kg. The single cocoon wt., Single shell wt. and S/R %, 1.59(g), 0.317(g) and 20.13%, respectively, were also recorded better in Tr-12 followed by S-140 with 11.73 kg, 1.57 gm, 0.320gm and 20.38%, respectively. Statistical analysis of the data reveals that it was found statistically significant on parameters such as Yield/10000 larvae (By Wt. kg), SCW (g), SSW (g) and S/R%. The statistical analysis of the data also reveals that it was found statistically significant on all these parameters to control i.e. S-146.

15. Post cocoon parameters during spring 2020: Post cocoon parameters result presented as under show that performance of all varieties was as per norms and reelability was at around 80%, however, maximum filament length was maximum in S-140 i.e. 1052 meter.

| Variety | Filament length (m) | Denier | Renditta | Reelability % |
|---------------|---------------------|---------|-----------|---------------|
| S-1635 | 1021 | 2.7 | 7.67 | 79.03 |
| Tr-10 | 898 | 2.7 | 7.22 | 81.27 |
| S-140 (PPR-1) | 1052 | 2.8 | 6.69 | 81.18 |
| Vishala | 1051 | 2.4 | 8.63 | 78.14 |
| Tr-13 | 1087 | 2.8 | 7.58 | 80.12 |
| S-146 | 1010 | 2.7 | 6.25 | 82.72 |
| Mean | 1019.83 | 2.68 | 7.34 | 80.41 |
| Range | 898-1087 | 2.4-2.8 | 6.25-8.63 | 78.14-82.72 |

16. Post cocoon parameters during autumn 2020: Post cocoon parameters result presented as under show that all varieties performance was as per norms and reelability was at around 80%, however Filament length was found maximum in S-1635 followed by S-140 i.e. 993.50m and 962.00m, respectively.

| Variety | Filament length (m) | Denier (d) | Renditta (kg) | Reelability (%) |
|---------|---------------------|------------|---------------|-----------------|
| S-1635 | 993.50 | 2.60 | 7.085 | 79.085 |
| Tr-10 | 865.00 | 2.55 | 7.256 | 81.165 |



| | | | | |
|---------------|-----------------|------------------|--------------------|---------------------|
| S-140 (PPR-1) | 962.00 | 2.60 | 7.214 | 80.485 |
| Vishala | 920.50 | 2.45 | 8.161 | 79.00 |
| Tr-23 | 959.50 | 2.60 | 7.138 | 80.580 |
| S-146 | 898.00 | 2.55 | 6.929 | 81.315 |
| Total | 5598.5 | 15.35 | 43.783 | 481.6 |
| Mean | 933.08 | 2.56 | 7.30 | 80.27 |
| Range | 865- 993 | 2.45-2.60 | 6.929-8.161 | 79.00-81.315 |

On the basis of results obtained on different parameters, moisture%, Moisture Retention Capacity%, moulting % all 06 mulberry varieties were found good, however data recorded on Bio-chemical analysis viz. Total Soluble Carbohydrate (TSC) (mg/g dwt) Total Soluble Protein (TSP)(mg/g dwt) and Total Chlorophyll Content (TCC) (mg/g dwt) at all 03 sites and Bioassay studies show that 02 mulberry varieties i.e. S-140 (PPR-1) and Tr-10 were found superior to other varieties and also S-146 which was taken as control under this experiment. Statistical analysis of the data on these parameters was also found significant at 5% level of significance.

CONCLUSION

After compilation of all data on morphological characters, rearing parameters and post cocoon parameters, it was observed that out of 06 mulberry varieties tested under this experiment, Tr-10 and S-140 (PPR-1) are recommended for raising of plantation and maintenance, at all the three sites viz. Sahaspur, Bageshwar and Almora (03 different altitudes) for increasing the mulberry wealth in the field, which will enhance the cocoon production at farmers level. (Dhar *et al*, 1997).



Mulberry variety Tr-10



Mulberry variety S-140 (PPR-1)



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