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RESCHEDULING OF BRUSHING DATE FOR COMMERCIALIZATION OF SILKWORM REARING (*BOMBYX MORI* L.) IN THE AUTUMN SEASON- A STUDY IN DOON VALLEY

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ABSTRACT

Sericulture is an essential economic activity in North Western India, particularly in Uttarakhand, contributing to rural livelihoods. However, the success of the autumn mulberry silkworm crop has been hampered by challenges such as temperature fluctuations, pest attacks, and the use of over-matured leaves. In the context of climate change and the need for sustainable sericulture, a two-year study was conducted in Doon Valley to investigate the effects of rescheduling pruning and brushing dates on the autumn silkworm crop. The experiment involved different pruning and brushing schedules, with observations made on parameters such as larval weight, defective cocoon percentage, cocoon productivity, single cocoon weight, single shell weight, and shell ratio. Statistical analyses were performed to assess the impact of these schedules on silkworm rearing. The results indicated that the timing of pruning and brushing significantly influenced various aspects of silkworm rearing. Notably, pruning mulberry trees in early July and brushing in September led to improved outcomes, including higher larval weight, lower defective cocoon percentage, increased cocoon productivity, and better cocoon quality. These findings align with previous studies highlighting the importance of using freshly pruned leaves for rearing. In conclusion, this research underscores the significance of proper scheduling of pruning and brushing dates to enhance the success of the autumn silkworm crop. By optimizing these practices, sericulturists can mitigate the adverse effects of temperature fluctuations and pests, thereby contributing to the sustainability of the sericulture industry in the region. This study also emphasizes the need for further research on season-specific mulberry and silkworm varieties to adapt to changing climatic conditions and ensure the long-term viability of sericulture in North Western India.

KEYWORDS: ***Brushing, Pruning, Rescheduling, Season Specific, Silkworm rearing***

1. INTRODUCTION

Like other North Western states of India mulberry sericulture is also practiced in Uttarakhand to augment livelihood of rural masses. The state has congenial climate and topography for producing bivoltine silk particularly during Spring season as majority of silk production occurs during spring. Small proportion of cocoon production occurs during autumn, when the temperature fluctuation is more and also the attack of pests and diseases is also high (Rudramani *et al*, 2019). Also mulberry leaf is too mature because of absence of pruning practices and more than four months in between the spring crop harvest and start of autumn brushing. Previous studies have already confirmed that sericulture mainly sustains on the mulberry trees grown on roadsides, banks of rivers, departmental gardens in North West India (Dhar and Bindroo, 1997). Further, the autumn crop has yet to be stabilized for sustainability of sericulture industry in North West part of country in general and Uttarakhand in particular. A preliminary survey was conducted before the start of research programme and it was found that the hills and foot hills of Doon valley are more suitable for bivoltine silkworm cocoon production in Uttarakhand, but still there is a gap between productivity at lab and at farmers level (Aslam *et al*, 2019_a; Khan *et al*, 2020). Research on different aspects have been carried out to arrive at a comprehensive solution to stabilize autumn crop (Aslam *et al*, 2019_c). But as per Miyashita 1986, the highest contribution for a successful mulberry silkworm cocoon crop comes from mulberry leaves (38.2%), followed by climatic conditions of rearing (37.0%) race/ hybrid (4.25%) and quality of silkworm eggs (3.1%). The package of practices of mulberry silkworm rearing followed in Doon valley have been developed in Southern states where climatic conditions are favorable throughout the year and with slight modifications have been applied in Northern conditions but with less effect on stabilizing autumn crop (Dhingra *et al*, 2000; Khan et al, 2018).

Further, rise in global atmospheric temperature along with increase in concentration of green house gases like nitrous oxide,

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carbon dioxide, methane, hydrochlorofluorocarbons and ozone have also raised an alarm (Yadav *et al*, 2020) . A number of explanations have been under discussion about the predictions been made on possible effect of climate change on sericulture industry (Neelaboina *et al*, 2018). Several researchers from India, have predicted that accumulation of green house gases with rise in temperature may alter production practices and performance of sericulture particularly in temperate regions and to some extent in tropical regions of the country (Ram *et al*, 2016).

In view of the climatic scenario due to global warming and long term call to stabilize autumn silkworm rearing in Northern India, rescheduling the brushing date for autumn season and accordingly pruning dates needs to be further worked on along with developing season specific mulberry and silkworm varieties. With this background the research work was carried out at RSRS, Sahaspur, Dehradun for two years from 2020-2022, to stabilize autumn silkworm crop through rescheduling pruning practices of mulberry and altering brushing dates of silkworm.

2. MATERIALS AND METHODS

The mulberry plantation utilized under the experiment at RSRS, Sahaspur was pruned with 5 treatments along with two control (Table 2) and was maintained as per the mulberry package and practices for sub-tropical areas(Table 1). For Chawki and late age rearing S-146 mulberry variety (tree mode) was used.

Table: 1 Details of mulberry experimental plantation, cultural operations and inputs.

Details of mulberry plantation	Cultural operations and inputs
a. Name of silkworm hybrids: SH6 x NB4D2 b. Number of Replications = 03 c. Name of mulberry variety = S-146 d. Mode of plantation: Tree e. Age of plants :8-10 years old f. Spacing : 8'X 8' (240 × 240 cm) g. No. of plants per experiment : 10 h. Basal Pruning in the month of June-July and middle pruning in the month of December-January	a. FYM – 10-20 kg /plant/year b. Chemical fertilizer- Per plant/year in two split doses i.e., February and August. c. Urea :167 gm (1st Dose) + 271gm (2nd Dose). (Nitrogen-46%) ; d. DAP :271 gm. (Nitrogen-16% and Phosphorous-84%); e. MOP :208 gm (Potash-100%), f. Digging/weeding in the month of January-Feb and July

Ten (10) DFLs of SH6 x NB4D2 for each treatment were incubated and brushed as per the below mentioned brushing treatment schedule (Table 2). The data was recorded on following parameters i.e, Weight of 10 mature silkworm larvae (g), Defective cocoon percentage, Cocoon yield/100 DFLs in kilograms, Single Cocoon Weight in grams, Single Shell Weight in grams and SR (%).

2. 1 Weight of 10 mature larvae: Ten larvae were randomly selected and weighted on digital balance to determine weight of 10 mature larvae.

2. 2 Defective cocoon (%): The total defective cocoon were calculated from the available 250 cocoons from 250 larvae by the following formula and were expressed as a percentage using the following equation

Defective cocoon (%) = {No. of good cocoons – No. of (flimsy + double +stained) cocoons × 100.

2.3 Cocoon yield/100 DFLs (Productivity) : It was calculated by weighing cocoons harvested from the 250 larvae and converting it into cocoons harvested from 40000 larvae.

2.4 Single Cocoon Weight: Ten cocoons were randomly selected and weighted on digital balance to determine the single cocoon weight by using the following formula
Single cocoon weight = Weight of 10 cocoon (g) /10

2.5 Single Shell Weight (g): Ten cocoon shells from each replicate were weighted on digital balance to determine single shell weight.
Single shell weight = Weight of 10 cocoon shells (g) /10

2.6 Shell Ratio (%): The total quantity of silk available from a single cocoon was expressed as a percentage using the following equation
Shell ratio = (Single cocoon shell weight (g) / Single cocoon weight (g)) × 100

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Table 2: Details of treatments

Treatment 01	Treatment 02	Treatment 03 (Control)
Mulberry plantation: *Sub treatment:* Shoot harvesting during spring season and no pruning followed during the month of June/July for autumn rearing as practiced by farmers.	**Mulberry plantation:** *Sub treatment :* Date of pruning (55 days before the proposed date of brushing): 1. 25th June. 2. 30th June 3. 05th July 4. 10th July 5. 15th July	**Mulberry plantation:** *Sub treatment :* Pruning under taken in last week of June/first week of July for autumn rearing as practiced presently.
Silkworm rearing: *Sub treatment –* Date of brushing: 1. 20th August. 2. 25th August. 3. 30th August. 4. 05th September 5. 10th September (Control).	**Silkworm rearing:** *Sub treatment –* Date of brushing: 1. 20th August. 2. 25th August. 3. 30th August. 4. 05th September 5. 10th September (Control).	**Silkworm rearing:** *Sub treatment –* Date of brushing: 1. 20th August. 2. 25th August. 3. 30th August. 4. 05th September 5. 10th September (Control).

A view of the Experimental Site

Cocoon Production in Autumn Season

2.4 Statistical analysis:-The effect of different pruning/brushing dates on six parameters of silkworm rearing were subjected to one way analysis of variance followed by post-hoc test (Tukey test) for comparison of means.

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Table 3: Two years pooled analysed data.

Name of parameter	Treatment		Mean±SE	F/df/P(Sig)
	Date of pruning	Date of brushing		
Weight of 10 mature worms (g)	20th June	20th August	42.6667±0.333^{c}	7.437/6/0.001
	30th June	25th August	43.0000±0.000^{c}	
	5th July	31st August	43.3333±0.440^{c}	
	10th July	5th September	42.3333±0.666^{b,c}	
	15th July	10th September	42.1667±0.166^{b,c}	
	2nd July	25th August	40.8333±0.440^{a,b}	
	No pruning	10th September	40.3333±0.440^{a}	
Defective cocoon%	20th June	20th August	46.5333±1.484^{e}	75.334/6/0.000
	30th June	25th August	35.5333±0.290^{c}	
	5th July	31st August	23.4000±0.416^{a}	
	10th July	5th September	39.4000±0.808^{d}	
	15th July	10th September	31.4000±0.115^{b}	
	2nd July	25th August	40.0667±0.466^{d}	
	No pruning	10th September	35.2667±1.266^{c}	
Productivity (Kg)	20th June	20th August	46.3333±0.285^{a}	462.590/6/0.000
	30th June	25th August	54.4367±0.148^{b}	
	5th July	31st August	62.4067±0.229^{e}	
	10th July	5th September	54.9667±0.110^{b,c}	
	15th July	10th September	63.2467±0.224^{e}	
	2nd July	25th August	55.8233±0.209^{c}	
	No pruning	10th September	58.6067±0.479^{d}	
Single cocoon weight (g)	20th June	20th August	1.7000±0.030^{a,b}	21.547/6/0.000
	30th June	25th August	1.7333±0.008^{b,c}	
	5th July	31st August	1.6367±0.006^{a}	
	10th July	5th September	1.8167±0.026^{d}	
	15th July	10th September	1.8533±0.012^{d}	
	2nd July	25th August	1.8533±0.006^{d}	
	No pruning	10th September	1.7933±0.0176^{c,d}	
Single shell weight(g)	20th June	20th August	.3200±0.005^{b}	15.848/6/0.000
	30th June	25th August	.3233±0.003^{b,c}	
	5th July	31st August	.2933±0.003^{a}	
	10th July	5th September	.3267±0.003^{b,c,d}	
	15th July	10th September	.3400±0.000^{c,d}	
	2nd July	25th August	.3433±0.003^{c,d}	
	No pruning	10th September	.3333±0.006^{b,d}	
SR%	20th June	20th August	18.7967±0.016^{b}	5.227/6/0.005
	30th June	25th August	18.7167±0.173^{b}	
	5th July	31st August	17.9300±0.110^{a}	
	10th July	5th September	18.1733±0.173^{a,b}	
	15th July	10th September	18.2567±0.051^{a,b}	
	2nd July	25th August	18.3500±0.191^{a,b}	
	No pruning	10th September	18.6067±0.145^{b}	

3.RESULTS AND DISCUSSION

The results from pooled data of two years revealed that the date of pruning and brushing had significant effect (F=7.437., df=6.,P=0.001) on the weight of ten mature larvae. The highest weight (43.33g) of 10 mature larvae was observed on the pruning date 05th July/ brushing date 31st August and lowest weight (40.33g) of 10 mature larvae was observed on no pruning/brushing date of 10th September and

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the difference was significant. Further, Tukey test revealed that 30 June/5th July/10th July/15th July pruning dates and subsequent brushing dates 25th August/ 31st August/ 5th September/ 10th September are significantly different than that of no pruning/10th September brushing. The results are in conformity with Bhatia *et al*, 2013; Aslam *et al*, 2019_b; Singh and Murli, 2021 who had reported that pruning of mulberry trees atleast two months before brushing in September, by utilizing the leaf for summer crop in the month of June will be a natural remedy for stabilizing the autumn crop, because this leaf harvesting would act as pruning for mulberry trees and will provide leaf of maximum of 80 days in the month of September as against more than four months old leaf used for autumn. This practice will not only help in stabilizing autumn crop and increase yield through feeding quality mulberry leaves but will also open avenues for third crop in between spring and autumn in North Western India. Therefore revalidation of pruning schedule is required as evident from lowest weight of larvae fed on leaf of unpruned mulberry trees with leaf age of more than 120 days.

Further date of pruning/brushing also had significant effect (F=75.33., df=6.,P=0.000) on the defective cocoon percentage. The highest percentage of defective cocoons (46.53%) was observed on pruning date 20th June/brushing date 20th August and lowest (23.4%) on pruning date 5th July/ brushing date 31stAugust and the difference was significant. Tukey test further revealed that 5th July pruning/31st August brushing is significantly different from 15th July pruning/10 September brushing followed by 30th June pruning/ 25th August brushing followed by 10th July pruning/ 2nd July Pruning and subsequent brushing on 5th September/ 25th August followed by 20th June pruning and subsequent brushing of 20th August. This result is in confirmation to the earlier work of other researchers Rahmatullah *et al*, 2012; Verma *et al*, 2016; Sarkar, 2020; Sharma *et al*, 2023 who have reported that the bivoltine hybrids were most susceptible to disease infection in monsoon seasons. Developmental process of silkworm is affected by precipitation, humidity, temperature, air, light and any change in the proportion of these factors may lead to pessimistic result. Rearing room temperatures will give good results with less number of defective cocoons only when proper hygienic conditions and quality leaf feeding would be maintained. Because during wet summer due to sufficient rainfall luxuriant growth of mulberry leaves occurs, but due to high rainfall, fluctuation of temperature also happens which is harmful for silkworms. During late august monsoon would be in receding stage and in September effects of humidity, temperature would be less and disease incidence would be also be less, resulting in lesser number of defective cocoon percentage as compared to August month.

In case of productivity results revealed that there was significant effect (F=462.59., df=6.,P=0.000) of pruning date/brushing date on cocoon productivity. The cocoon productivity was highest (63.24kg) on the pruning date of 15th July/brushing date of 10th September and lowest (46.33kg) on pruning date of 20th June/brushing date of 20th August and the difference was significant. Tukey test further revealed that 15th July/5th July pruning and subsequent brushing on 10th September/ 31st August is significantly different from all other treatments. The results are in confirmation with Singhal *et al*, 2003; Shabnam *et al*, 2018 who reported that cocoon production and productivity is affected by the quality leaf and the number of feeds per day. Best season to get good productivity from autumn rearing is to conduct it in September-October, but the leaf should be fed from the mulberry trees which have been pruned in June/July not as against the practice of feeding over mature leaf which comes after Spring harvesting in April in sub tropics. Further the number of feeds of quality leaf should not been less than three feeds per day and will directly depend on quantity of quality mulberry leaf availability.

Similarly in case of single cocoon weight results revealed that there was significant effect (F=21.547., df=6., P=0.000) of pruning/brushing date on weight of single cocoon. Highest single cocoon weight (1.8533gm) was observed in case of pruning date of 15th Jul / brushing date 10th September and lowest (1.63gm) in case of 5th July pruning date/31st August brushing date and difference was significant. Further Tukey test revealed that 15th July/10th July/2nd July subsequent brushing on 10th September/5th September and 25th August were significantly different from other treatments. The results are in confirmation with Thiagarajan *et al*, 1993; Kato *et al*, 1998; Sarkhel *et al*, 2017; Kaveri *et al*, 2020 who had reported that the seasonal fluctuations affects the morphological aspects such as length & weight of larvae, diameter & weight of cocoon and biochemical aspects of silkworm such as protein content of silk-gland and cocoon. At 21-24°C temperature and 67% RH, cocoon weight, shell weight, and filament length will be maximum. Heat as well affects cocoon characters and larvae stages and 5th instar larvae is more susceptible to heat than 1st, 2nd, 3rd and 4th instar larvae. Therefore natural remedy to avoid the heat and temperature would be to conduct silkworm rearing in September and not in August for stabilizing autumn crop.

Results for single shell weight revealed that pruning date/brushing date had significant effect (F=15.848., df=6.,P=0.00) on shell weight. Highest single shell weight(0.3433gm) was observed in case of pruning on 2nd July/brushing 25th August and lowest(0.2933gm) in case of pruning 5th July/ brushing 31st August and the difference was significant. Further Tukey test revealed that 2nd July/15th July/10th July/ 30th June/20th June and subsequent brushings on 25th August/ 10th September/ 5th

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September/25th August/ 20th August were significantly different from 5th July pruning /31st August brushing. The results are in confirmation with Alebiosu *et al*, 2014; Sharma *et al*, 2023 who have reported that larval and pupal weights, single shell weight, number of cocoons, single cocoon weight were significantly higher when the silkworms feed consisted of leaves from pruned mulberry plants. However, cocoon shell mainly made of proteins and the fibroin synthesis being high towards the end of fifth instar. As silk gland-body ratio (GBR) of silkworm records positive growth under the impact of nutritionally high mulberry leaves with high concentration of proteins. During monsoon season nutrient concentration is high, but under field conditions it is difficult to control temperature and humidity at farmer level particularly in the month of August, so a better option would be to conduct silkworm rearing in the month of September but leaf to be fed from pruned trees only with leaf age not more than 80 days.

The results in case of Shell Ratio(%) revealed that date of pruning/brushing had a significant effect (F=5.227., df=6.,P=0.005) on Shell Ratio(%). The highest Shell Ratio(%) (18.79) was observed in case of pruning date of 20th June / brushing date of 20th August and the lowest (17.93m) was observed on pruning date of 5th July/ brushing date of 31st August and the difference was significant. Further Tukey test revealed that 20th June/30th June pruning dates and subsequent brushing dates are significantly different from pruning date of 5th July/31st August. Further 20th June/30th June/10th July/ 15th July and subsequent brushing on 20 August/25th August/ 5th September/ 10th September are not significantly different. The results are in confirmation with Rahmathulla and Suresh, 2012; Nooruldin *et al*, 2015 who have reported that almost all the macronutrients exhibited stable concentration in mulberry leaf during 1st fortnight of August month and nutritional efficiency is higher during rainy seasons only where optimum temperature and humidity are maintained inside rearing rooms.

4. CONCLUSION

The research aimed to stabilize the autumn crop of mulberry silkworm (*Bombyx mori* L.) through rescheduling of pruning and brushing dates in the Doon Valley region of Uttarakhand, India. The study focused on addressing the challenges posed by temperature fluctuations, pests, diseases, and the use of over-mature mulberry leaves for the autumn crop. The experiment was conducted over two years, and various parameters were assessed to determine the impact of different pruning and brushing schedules on silkworm rearing and cocoon production. The findings of the study provide valuable insights into the optimal timing for pruning and brushing, which significantly influence the quality and quantity of cocoon production. The study's results underscore the significance of proper timing in mulberry silkworm rearing to achieve successful and sustainable autumn cocoon production. Furthermore, the study provides practical recommendations for sericulturists and farmers in the region to enhance autumn cocoon production and contribute to the stability and growth of the sericulture industry. In light of the anticipated effects of climate change and the need for sustainable sericulture practices, the research outcomes offer valuable guidance for adapting mulberry silkworm rearing strategies to changing environmental conditions. Further studies and practical implementations based on these findings could help bridge the gap between laboratory-based research and on-field cocoon production, ultimately supporting the livelihoods of rural communities and fostering the sustainability of the sericulture industry in the Doon Valley and similar regions.

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