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Growth performance of the *Bombyx mori* (Hybrid CSR2 x CSR4) using G4 and MR2 mulberry varieties

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Abstract
The silkworm industry plays a crucial role in requiring employment opportunities, particularly in regions like Tamil Nadu, Assam, Karnataka, West Bengal, Jharkhand, and Andhra Pradesh. This industry heavily relies on mulberry plants *Morus alba L.* as the primary food source for silkworms *Bombyx mori.* This study was conducted at Mukkudal (80.756102 N, & 77.526425E). A sum five trays of *B. mori* samples were collected for the experiment. The growth and development of silkworm larvae fed two different mulberry leaf variants, G4 and MR2, The MR2 mulberry Verity elicits a below-average growth rate. However, in the later 5th instar, silkworms fed on MR2 exhibit significantly higher growth performance. Larval duration was also notably decreased by using MR2 leaves. The MR2 shortened the 5th Instar cycle by 24 hours to just 168 hours (7 days), compared to 192 hours (8 days) with G4. Overall, the MR2 mulberry variety clearly stimulates superior improvements in both cocoon weight and faster mature development in advanced instar silkworms. Further research into optimal rearing conditions with the MR2 host plant is recommended to support higher efficiency and yield in silk production.

Keywords: Growth performance, silkworm, mulberry and life cycle

Introduction
In India, sericulture farming Industry: different environmental and climatic conditions for different types of silkworms used (Mulberry, Tasar, Eri, and Muga) were cultivated in India [1]. While the cottage industry that provides jobs for people in rural areas is sericulture, over time, India's mulberry farming sector will raise 60% of the world's bi-voltine silkworms [18]. Whereas silkworm pupae are regarded as the primary by-product of the sericulture industry, silkworm Bombyx mori are insects that can convert plant proteins into silk [3]. Mulberry *Morus spp*. is an important plant in the sericulture industry, as foliage constitutes the essential feed for mulberry silkworm (*Bombyx mori* L.) [12]. The G4 variety is characterized by open type bushes, fast growing and high branching. Branches are straight, greyish with short inter-nodes. Leaves are dark green, unlobed, cordate, thick with wavy surface. It has high rooting ability. Under assured irrigation and recommended package of practices it yields 65 mt/ha/year. The variety is recommended for late age silkworm [18]. The MR2, G4, and V1 mulberry varieties had a good response to chitosan treatments compared to the control under an unstressed condition [13]. The genetic variability in physiological and biochemical traits in a mulberry variety with an MR2 chlorophyll stability index of 74%, compared to a higher G4 variety mulberry plant [4]. In this study aimed at analyzing the growth performance of silkworms using MR2 and G4 mulberry plant varieties, it was found that one variety significantly impacted the growth performance of silkworms more than the other. The superior mulberry plant variety is recommended for future use in silkworm cultivation.

Materials and Methods
1. Description of the study area
Mukkudal is famous for its location along the Thamirabarani river in Tirunelveli, Tamil Nadu, India. It falls under the Cheranmahadevi-Taluk administration. The study site is located at coordinates (80.756102 N, & 77.526425E). Periodic visits were conducted, and data was regularly collected through both direct observation and from farmers.

2. Field Setup
The experiment was carried out from January 2020 to February 2022 at the experimental site, which has a 35' x 60' rearing house. Inside the rearing house, there are three rearing stands, each with six rows. Mildew Resistant Variety 2 (MR2) mulberry plant *M. alba* was developed by the Sericulture Department, Govt. of Tamil Nadu [10]. The G4 variety was developed in 2003 from cross-pollinated hybrids of *Morus multicaulis* and S-30 [19]. In this study silkworm, bivalent CSR2 X CSR4 hybrid was used**.** Naturally healthy silkworms were selected for these studies. MR2 and G4 mulberry leaves were fed to silkworms that were randomly selected in groups of five counted silkworms for each rearing bed. The selected silkworms were then analyzed for weight (g) and length (cm).

3. Statistical Analysis
The last two-instar growth parameters were analysed by One-way Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) using a commercially available statistics software package (SPSS® for Windows, V. 16.0, Chicago, USA). Results were presented as Mean ± Standard Error (Sokal,1981) [15].

Results
1. Growth Performance
The growth performance of silkworms using G4 and MR2 mulberry leaves shows that the MR2 variant mulberry leaves give average performance in the 4th instar Fig. (1). However, in the 5th instar, the silkworms fed MR2 mulberry

leaves dominate in growth performance Fig (2), demonstrating the difference in growth.

2. Larval Duration

Larval duration is significantly decreased in the 4th and 5th instars when using MR2 mulberry leaves (168 hours, 7 days), respectively, compared to the G4-fed mulberry leaves (192 hours, 8 days). Fig. (2) shows a difference in the larval duration of both instars.

3. Cocoon Weight

Silkworms fed MR2 leaves produced cocoons with the highest value of 8 grams. In contrast, silkworms fed the G4 mulberry variety yielded cocoons with a high value of 7 grams, as shown in Table 1 and Fig. 4, which display the differences between the cocoons. The morphometric growth rate of IV instar and V instar larvae was compared to G4 and MR2-fed *B. mori* (Fig. 5a-5d). The morphometric growth rate, like length and weight parameters, of *B. mori* fed with G4 and MR 2 mulberry leaves the mean length and weight of IV instar larvae in the 'G4 group' were (2.1±0.06 and 0.8±0.09), respectively. The mean length and weight of IV instar larvae in the 'MR 2 group' were (2.2±0.13 and 0.43±0.02), respectively. The mean length and weight of V instar larvae in the 'G4 group' were (6.6±0.24 and 4.7±0.33), respectively. The mean length and weight of the V instar larvae of the 'MR 2 group' were (7.1±0.29 and 6.1±0.07), respectively Table (3). In these four observations, the IV instar 'G4 Group' of length and weight was significantly increased, followed by the MR2 IV instar, and the V instar 'MR2 group' of length and weight was significantly increased, followed by the 'G4 V instar group'.

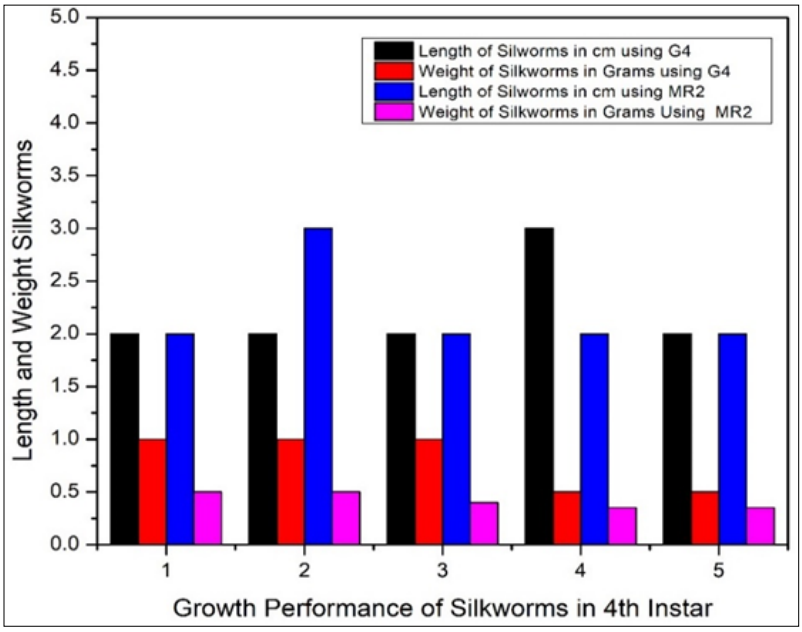

Fig 1: Growth performance of *B. mori* in 4th instar

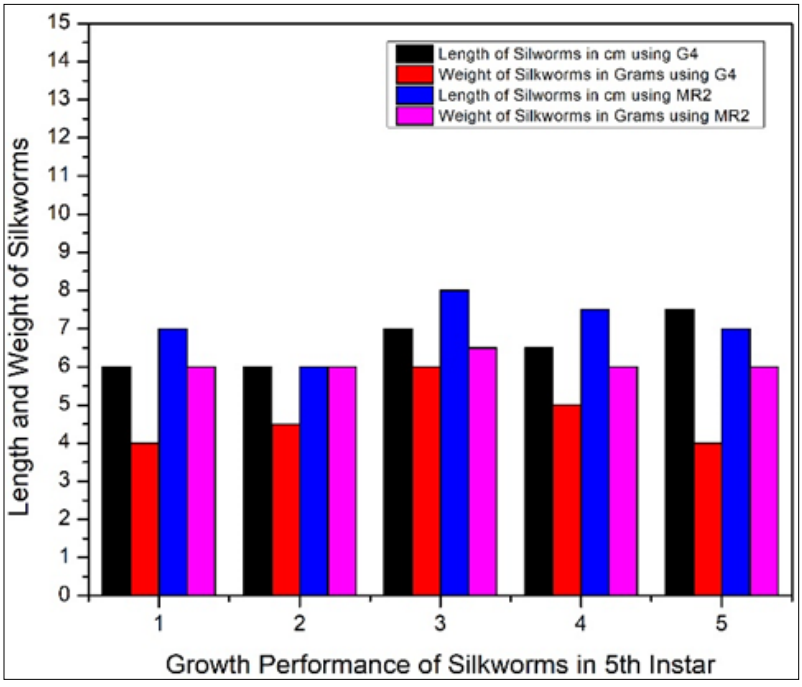

Fig 2: Growth performance of *B. mori* in 5th instar

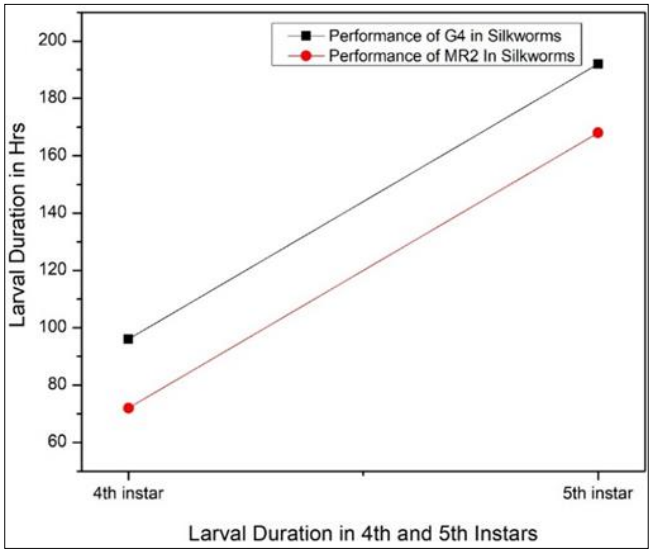

Fig 3. ***B:*** *mori* larval duration (in Hrs)

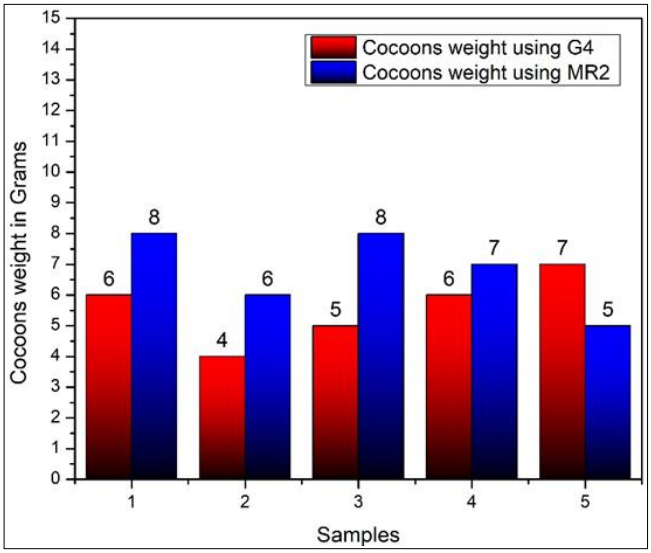

Fig 4 ***B:*** *mori* cocoons weight (in Grams)

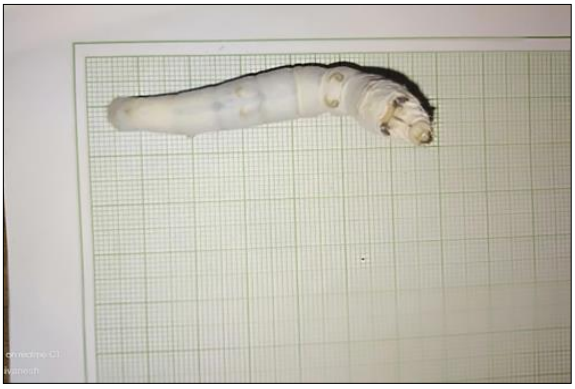

Fig 5(a): *B. mori* 5th Instar

Fig 5(d): *B. mori* 5 th Instar

Fig 5(b): *B. mori* 4th Instar feeds on MR2

Fig 5(e): *B. mori* Cocoons

Fig 5(c): *B. mori* 4th Instar feeds on G4

Table 1: Morphometric growth rates of IV instar and V instar larvae of *Bombyx mori* fed with different verities of mulberry leaves MR2 and G4.

Sample	Length ±SE	Weight ±SE
G4-4	2.1±0.06[a]	0.8±0.09[a]
MR2-4	2.2±0.13[a]	0.43±0.02[a]
G4-5	6.6±0.24[b]	4.7±0.33[b]
MR2-5	7.1±0.29[b]	6.1±0.07[c]

Discussion

Ramamoorthy [7] reported that G4 mulberry varieties have recorded the highest biochemical constituents and are suitable for silkworm rearing to get maximum cocoon-related parameters. Meeramaideen [11] analyzed the growth rate of IV and V instar morphometric analysis and economic parameters of silkworm Bombyx mori larvae to comparatively enhance the silkworm fed with 2.5% amino acid lysine-treated MR2 mulberry leaves compared to control. Guled and Anusha [5] reported that silkworms fed with leaves of the MI-79 and MR-2 genotypes had increased larval weight, decreased larval duration, maximum cocoon weight, shell weight, shell ratio, silk productivity, silk filament length, silk filament weight, and denier. Compared to other genotypes, genotypes MI-79 and MR-2 can be recommended for trials at field level by farmers, and furthermore, they could be exploited for commercial purposes like V-1. Sudhakar [16] analyzed G4 as strong in nurseries, healthy against pests, and most suitable for bivoltine silkworm rearing, thereby encouraging the farming community to adopt and rear G4 for enhanced quality cocoon production. Mahavishnu [8] found that silkworm larvae fed on MR2 leaves soaked with a 300ppm concentration of Spirulina (group T4) significantly increased the larvae and cocoon length, width, and weight, cocoon shell weight, pupal weight, shell ratio, and silk filament length. Sangamithirai [14] analyzed the larval and cocoon length, width, and weight, which were significantly increased in some groups. The total body weight gain on a wet weight basis was significantly higher in Spirulina-treated MR2 mulberry leaves, followed by the control MR2 mulberry leaf. Among the MR2 mulberry leaves, Spirulina-treated MR2 mulberry leaves have gained the maximum body weight. Manjunath *et al.* (2023) [9] have reported, G4 Short internodes, fast-growing, straight branches, and leaves have thick and wavy margins. Suitable for late-age silkworms. Susikaran and Vijay [17] analyzed that variety V1 is prone to various pests and diseases compared to variety G4. But comparing the yield parameters, V1 is highly suitable for tree-type cultivation. Kumar [6] reported that using MR2 Mulberry with feed supplementation of 5% Spirulina to silkworms was beneficial to the sericulture industry in India by ultimately increasing the quantity of quality silk production economically. Kumar [7] report that variety V1 has a highly heat-stress-tolerant capacity, followed by varieties MR2 and S36. Deepa [2] reported that the antibacterial activity of mulberry fruit extracts of G4 and MR2 showed the highest antibacterial activity against human bacterial pathogens like *Staphylococcus aureus*, *Streptococcus pneumonia*, and *Staphylococcus epidermidis.*

Conclusion

In this study, the mulberry varieties MR2 and G4 give variation in growth rate in the 4th instar, while silkworms fed MR2 leaves show improved weight and growth in the 5th instar. Further research into optimal rearing conditions with the MR2 host plant is recommended to support higher efficiency and yield in silk production.

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Competing interests

The authors declare that they have no competing interests.

Authors' Contributions

Conceptualization: HS, RA. Data curation: HS, Formal analysis: HS, DS, RA. Investigation: DS, Methodology: HS, DS. Resources: HS. Supervision: DS. Visualization: DS. Project administration: DS. Software: HS. Validation: HS. Writing – original draft: HS. Writing – review and editing: HS, RA.

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