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Rearing performance of BFC1×BFC10 double hybrid silkworm with reference to FC1×FC2 silkworm, *Bombyx mori* L. in Kolhapur district, Maharashtra

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Abstract
The present investigation was conducted to study the rearing performance of BFC1×BFC10 double hybrid silkworm with reference to FC1×FC2 silkworm in laboratory conditions to determine the pre- and post-cocoon parameters. The larval parameters results revealed that there was no significant difference between BFC1×BFC10 larvae to FC1×FC2 silkworm as well as adult fecundity. Further, cocoon parameters selected hybrid results were at par with FC1×FC2 cocoons. The reeling parameters such as average filament length, non-breakable filament length, denier, and filament weight results were at par with FC1×FC2 control. These findings indicate that, the BFC1×BFC10 double hybrid silkworm could be recommended for commercial rearing in western Maharashtra region as this area climatic conditions are similar to the southern Indian states like Karnataka.

Keywords: BFC1×BFC10, double hybrids, silkworm, rearing, cocoon

Introduction
Sericulture activities involve in both the mulberry cultivation and silkworm rearing suitable breed for production of good quality cocoons (Manimegalai *et al.,* 2023) [1]. India is the second largest silk producing country after China and it contributes approximately 18% of the world total raw silk (Kori *et al.,* 2022) [2]. Increasing demand for raw silk in the international market reveals the importance of silk production. For production of quality silk, the silkworm breeds are playing an important role (Thrilekha *et al.,* 2024) [3]. There are several institutions and universities that are working on silkworm breeding to enhance the silk quality and quantity in the world (Thrilekha *et al.,* 2024; He *et al*., 1991; Dandin, *et al*, 2006; Jalali *et al*., 2011; Bindroo *et al*, 2016) [3-7].
In India, silkworm breeding centres such as CSTRI, Mysore and other authorized by CSB Bangalore have developed the several double hybrid silkworms based on multiple traits evaluation. The bivoltine double hybrids including BFC1 × BFC 10, TT11 × TT56, G11×G19 and BCON1 × BICON4 have been commercialized in south Indian (Manimegalai *et al.,* 2023) [1]. Double hybrid breed of BFC1 × BFC10 silkworms are experimental reared in Karnataka, Andra Pradesh and Tamil Nadu states to determine the pre- and post-cocoon parameters (Manimegalai *et al.,* 2023; Pawar *et al.,* 2024) [1, 8]. In Maharashtra, only double hybrid of FC1× FC2 breed silkworms are rearing (Anonymous, 2020) [9]. Therefore, the present study was designed to evaluate BFC1 × BFC10 breed silkworms with references to FC1× FC2 silkworm breeds in laboratory conditions to determine the pre- and post-cocoon parameters.

Materials and Method
Five hundred double hybrid, BFC1 × BFC10 and FC1 × FC2 disease free layings (DFLs) procured from Silkworm Seed Production Center (SSPC), Bangalore, Karnataka. Silkworms were reared under laboratory conditions (26 ± 1°C temperature and 70 ± 5% relative humidity) using a stranded method (Datta *et al.,* 1996) [10]. Mulberry, *Morus alba* (V1 variety) chapped tender leaves were provided two times for chawki worms and for late age worms whole shoots for four times. This study was carried out during July-August, 2024 at Department of Zoology, Shivaji University, Kolhapur. Ten larvae and cocoons randomly picked from the rearing tray and Chandrika respectively with three replicates for observations.
The silkworm related parameters such as larval duration (h) and larval weight (g) were observed. Fifth instar larval duration was estimated by counting the total hours from first day of 5th instar to the spinning. Larval weight was recorded on the 5th day of 5th instar. The effective rate of rearing was determined using the following formula (% ERR = Number of cocoons harvested / Number of larvae brushed × 100), and fecundity was recorded. Post cocoon parameters such as single cocoon weight (g), single shell weight (g), and % shell ratio (% Shell ratio = Shell weight / Cocoon weight × 100) were calculated. The reeling parameters such as average filament length (Total filament length / Total number of cocoons reeled), and non-breakable filament length (Total filament length / 1+number of breaks) were determined after eight days of spinning. Dinner of the filament calculated (Weight of silk reeled / Length of reeled silk × 9000) and the silk filament weight was determined by using reeled silk were dried in an oven at 85°C and weighted on an electronic balance. Experimental data recorded were pooled and statistically analyzed ANNOVA using Excel software.

Result and Discussion
The FC1× FC2 double hybrid silkworms are popularly rearing in Maharashtra for commercial cocoon production as well as certain experience farmers produced seed cocoons. The results of the study showed that there was no significant difference between larval weight, larval duration of BFC1 × BFC10 double hybrid silkworms when compared to FC1× FC2 silkworm (Table 1). Larval weight is a vital characteristic feature that is responsible to influence both the larval health and the standard of the produced cocoon spun (Nguku *et al*. 2007) [11]. It indicates that, BFC1 × BFC10 double hybrids silkworms are suitable for south

western regions of Maharashtra particularly in Kolhapur district as this region climatic conditions are similar to south India (Sinha and Sathyanarayana, 2012) [12]. The BFC1 × BFC 10 double hybrid silkworms are experimentally reared at Kodathi and Chamaranagar in Karnataka state, Salem in Tamil Nadu state, and in Ananthapur in Andra Pradesh state Regional Sericulture Research Station (RSRS)/ Research Extension Centre (REC) to determine pre- and post-cocoon parameters for commercialization (Anonymous, 2020) [9]. Further, the selected (BFC1 × BFC 10) double hybrid silkworms were reared. The fecundity results showed the more than 400 eggs/moth, and it is analogous to the other double hybrid breeds including FC1× FC2 silkworms (Thrilekha *et al.,* 2024; Tekule *et al.,* 2018;) [3, 13].

The BFC1 × BFC10 cocoon parameters such as single cocoon weight, single shell weight, shell ratio, and effective rearing rate (ERR) results were not significantly different when compared to FC1× FC2 cocoon parameters (Table 2). These results confirm the results of Pawar *et al* (2024) [8], who reported the economic traits such as single cocoon weight, single shell weight, and shell ratio of FC1× FC2 silkworms with other double hybrid silkworms including BFC1 × BFC10 silkworms. Generally, the cocoon weight and cocoon shell weight are considered as major productive characters in sericulture (Nguku *et al,* 2007; Gaviria *et al,* 2006; Zanatta *et al,* 2009) [11, 14, 15]. Silk weight can also be determined by cocoon shell weight.

The reeling parameters of FC1× FC2 cocoon results such as average filament length, non-breakable filament length, denier and filament weight revealed the superiority of the BFC1 × BFC10 hybrid, however there were no significant differences between both results. Earlier report of Pawar *et al.* (2024) [8]. demonstrated that BFC1 × BFC10 filament length was lesser than the FC1× FC2 hybrids. The results of reeling parameters are correlated to findings of Thore *et al.* (2023) [16] they observed quite similar to our results. A bivoltine sericulture began with the new era to introduction of region and season specific silkworm hybrids and these hybrids confirm higher yields for primary producers and reelers (Thrilekha *et al.,* 2024) [3].

Conclusion: The selected BFC1 × BFC10 double hybrid silkworm results demonstrated the larval parameters, cocoon parameters and reeling parameters were similar to the regularly using FC1× FC2 hybrids in Maharashtra. These findings indicate that the BFC1×BFC10 double hybrid silkworm could be recommended for commercial rearing in western Maharashtra region as this region's climatic conditions are similar to the southern Indian states like Karnataka. For sericulturists adapting the best performing hybrids and implementing modern rearing practices can lead to higher cocoon yields and better-quality silk.

Table 1: Larval parameters and adult fecundity of BFC1 × BFC10 and FC1 × FC2 silkworms

Name of the hybrid	Larval weight (GM)	Larval duration (hrs.)	Fecundity (n)
BFC1×BFC10	31.56	174.30	388.1
FC1×FC2	30.52	172.00	382.0
CV%	4.20	2.17	2.24
SE±	0.29	0.84	1.93
CD at 5%	1.23	3.53	8.11
Significance level	Non-significant	Non-significant	Non-significant

Table 2: Cocoon parameters of BFC1 × BFC10 and FC1 × FC2 silkworms

Name of the hybrid	Single cocoon weight (gm)	Single shell weight (gm)	Shell ratio (%)	Effective rate of rearing (%)
BFC1 × BFC10	1.88	0.38	20.86	92.9
FC1 × FC2	1.90	0.40	22.93	93.6
CV%	0.89	1.73	4.28	0.94
SE±	0.003	0.0015	0.20	0.196
CD at 5%	0.015	0.006	0.84	0.82
Significance Level	Non-significant	Non-significant	Non-significant	Non-significant

Table 3: Reeling parameters of BFC1 × BFC10 and FC1 × FC2 silkworms

Name of the hybrid	Average filament length (m)	Non-breakable filament length (m)	Denier (d)	Filament weight (g)
BFC1 × BFC10	989.50	648.7	1.88	0.270
FC1 × FC2	994.2	652.50	1.90	0.297
CV%	0.53	0.59	1.24	7.27
SE±	1.17	0.86	0.0052	0.0046
CD at 5%	4.90	3.60	0.022	0.0194
Significance Level	Non-significant	Non-significant	Non-significant	Non-significant

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