BIOLOGICAL AND TECHNOLOGICAL CHARACTERISTICS OF INDUSTRIAL SILKWORM HYBRIDS DEVELOPED ON THE BASIS OF PARTHENOGENETIC CLONE-LINE BREEDS

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Abstract. This study evaluated the biological productivity and technological quality characteristics of industrial silkworm hybrids developed on the basis of parthenogenetic clone-line breeds. The reciprocal hybrids U-1 × U-2 and U-2 × U-1 were investigated during 2021–2026 and compared with the standard hybrid Ipakchi-1 × Ipakchi-2. The results demonstrated that the U-2 × U-1 hybrid exhibited superior biological performance, including larval viability (94.6±1.18%), cocoon weight (1.80±0.06 g), cocoon shell weight (426.2±15.8 mg), and silk ratio (24.0±0.42%), exceeding the control hybrid. Regarding technological traits, the U-1 × U-2 hybrid showed higher dry cocoon weight (0.766±0.03 g), silk yield (50.1±1.2%), and reelable filament length (1183±76 m), whereas the U-2 × U-1 hybrid achieved the highest metric number (3704±128 m) and total cocoon filament length (1270±71 m). The obtained results indicate a pronounced heterosis effect in hybrids derived from parthenogenetic clone-line breeds for both biological and technological traits. The findings confirm the breeding value of these genetic resources and demonstrate that the U-2 × U-1 hybrid is a promising commercial hybrid for modern sericulture.

Keywords: silkworm, *Bombyx mori L.*, parthenogenetic clone, industrial hybrid, biological productivity, silk ratio, cocoon shell weight, metric number, filament length, heterosis.

Introduction. The development of highly productive and high-quality commercial silkworm hybrids *(Bombyx mori L.)* remains one of the major objectives of modern sericulture. Recent advances in genetics and genomics have demonstrated the importance of utilizing valuable genetic resources for improving economically important traits and developing superior industrial hybrids (1).

Parthenogenetic clones are considered genetically stable breeding materials and play a significant role in silkworm improvement programs. Hybrids developed using parthenogenetic lines often exhibit stable expression of desirable economic traits and enhanced biological performance (2). Biological productivity and technological quality indicators are among the principal criteria used for evaluating newly developed silkworm hybrids and improving rearing technologies (3).

Previous studies on parthenogenesis and cloning in silkworms have shown that the use of parthenogenetic lines can enhance heterosis effects and increase breeding efficiency (4, 5). Comparative analyses of parthenogenetic and amphigenetic lines have further revealed several biological and physiological advantages associated with parthenogenetic breeding materials (6).

Recent developments in genome engineering and parthenocloning technologies have opened new opportunities for silkworm breeding programs (7). Moreover, molecular and proteomic studies have provided deeper insights into the mechanisms of parthenogenesis and established a scientific basis for the development of highly productive commercial hybrids (8).

In Uzbekistan, considerable attention has also been given to the utilization of parthenogenetic clones for the creation of new silkworm hybrids with improved biological and technological characteristics. Studies have demonstrated the effectiveness of combining parthenogenetic clones with fine-fiber silkworm breeds to obtain promising breeding materials and highly productive hybrid combinations (9, 10).

Therefore, the aim of the present study was to evaluate the biological productivity and technological quality characteristics of the U-1 × U-2 and U-2 × U-1 commercial silkworm hybrids developed from parthenogenetic clone-line breeds in comparison with the standard hybrid.

Materials and Methods. The study was conducted at the Sericulture Research Institute during 2021–2026. The U-1 clone-line breed was developed by crossing the parthenogenetic clone APK with the MG breed, while the U-2 clone-line breed was obtained from the cross between the parthenogenetic clone 9PK and the Ya-120 breed. Reciprocal crosses between these lines produced the industrial hybrids U-1 × U-2 and U-2 × U-1. The commercial hybrid Ipakchi-1 × Ipakchi-2 served as the control.

Larval viability, cocoon weight, cocoon shell weight, silk ratio, dry cocoon weight, silk yield, metric number, and filament length were evaluated. Data were processed using biometric methods, and mean values ($\bar{X} \pm Sx$) and coefficients of variation (Cv, %) were calculated.

Results and Discussion. The biological productivity of industrial silkworm hybrids is one of the most important indicators used to evaluate their breeding and commercial value. Traits such as larval viability, cocoon weight, cocoon shell weight, and silk ratio directly determine the economic efficiency of hybrid silkworms and are therefore considered key selection criteria. The successful combination of valuable genetic traits in parental lines can enhance these characteristics through heterosis effects.

In the present study, the biological productivity and silk yield characteristics of the reciprocal hybrids U-1 × U-2 and U-2 × U-1, developed from parthenogenetic clone-line breeds, were evaluated and compared with those of the commercial hybrid Ipakchi-1 × Ipakchi-2. The analysis was based on six years of observations (2021–2026), allowing a comprehensive assessment of the stability and productivity of the developed hybrids.

The obtained results demonstrated that both experimental hybrids exhibited superior performance in most biological traits compared with the control hybrid. The average values, coefficients of variation, and relative superiority of the studied hybrids are presented in Table 1.

Table 1.

Biological productivity and silk ratio indicators of industrial silkworm hybrids developed from parthenogenetic clone-line breeds (2021–2026)

№	Hybrids	Years	Larval viability, %	Average		Silk ratio, %
				cocoon weight, g	Cocoon shell weight, mg	
1	U-1 x U-2	2021	91.0	1.81	422	23.3
		2022	94.3	1.74	412	23.7
		2023	96.6	1.65	386	23.4
		2024	90.7	1.83	414	22.6
		2025	95.5	1.87	445	23.8
		2026	97.1	1.62	379	23.4
		X̄±Sx	**94.2±1.14**	**1.75±0.04**	**409.7±9.2**	**23.4±0.16**
		Cv,%	**2.97**	**5.79**	**5.52**	**1.71**
		Relative value, %	**104.7**	**101.7**	**105.1**	**103.1**
2	U-2 x U-1	2021	90.0	1.56	375	24.0
		2022	97.5	1.93	447	23.2
		2023	96.2	1.75	399	22.8
		2024	92.6	1.76	450	25.6
		2025	93.6	2.03	481	23.7
		2026	97.9	1.79	405	22.6
		X̄±Sx	**94.6±1.18**	**1.80±0.06**	**426.2±15.8**	**24.0±0.42**
		Cv,%	**3.05**	**7.96**	**9.09**	**4.26**

		Relative value, %	105.1	104.7	109.3	105.7
3	Ipakchi-1 × Ipakchi-2 (Control)	2021–2026 average	90.0±1.8	1.72±0.08	390±24	22.7±0.7
		Cv,%	5.8	11.2	14.1	7.1
		Relative value, %	100	100	100	100

The results demonstrated that both industrial hybrids developed from parthenogenetic clone-line breeds exhibited superior biological performance compared with the control hybrid Ipakchi-1 × Ipakchi-2 (Table 1). The average larval viability of the U-1 × U-2 hybrid reached 94.2±1.14%, while the U-2 × U-1 hybrid showed 94.6±1.18%, exceeding the control by 4.7% and 5.1%, respectively. The higher viability indicates better adaptability of the experimental hybrids to rearing conditions and reflects the positive effect of heterosis.

The average cocoon weight varied from 1.75±0.04 g in U-1 × U-2 to 1.80±0.06 g in U-2 × U-1, whereas the control hybrid produced an average cocoon weight of 1.72±0.08 g. The superiority of U-2 × U-1 over the control reached 4.7%, indicating its greater biological productivity.

A similar tendency was observed for cocoon shell weight. The highest value was recorded in the U-2 × U-1 hybrid (426.2±15.8 mg), which exceeded the control hybrid (390±24 mg) by 9.3%. The U-1 × U-2 hybrid also showed a higher shell weight (409.7±9.2 mg), surpassing the control by 5.1%. Since cocoon shell weight is directly associated with raw silk yield, these results indicate the high technological potential of the newly developed hybrids.

The silk ratio of the experimental hybrids ranged from 23.4±0.16% to 24.0±0.42%, while the control hybrid exhibited 22.7±0.7%. The highest silk ratio was observed in U-2 × U-1, which exceeded the control by 5.7%. This confirms that the reciprocal hybrid possesses a greater ability to accumulate silk proteins and produce a larger cocoon shell relative to total cocoon weight.

The coefficients of variation for larval viability (2.97–3.05%) and silk ratio (1.71–4.26%) were lower than those of the control hybrid, indicating greater biological stability and uniformity of the newly developed hybrids. Such stability is an important characteristic in silkworm breeding and commercial cocoon production.

Overall, the results revealed that reciprocal crossing of the clone-line breeds U-1 and U-2 produced hybrids with improved biological productivity and silk yield characteristics. Among the studied combinations, the U-2 × U-1 hybrid demonstrated the highest values for most economically important traits and can therefore be considered the most promising industrial hybrid for commercial sericulture.

The technological value of industrial silkworm hybrids is determined by cocoon filament quality characteristics, which directly influence raw silk production efficiency. Traits such as dry cocoon weight, silk yield, metric number, reelable filament length, and total cocoon filament length are considered important indicators for evaluating the industrial potential of newly developed hybrids. Therefore, the technological characteristics of the U-1 × U-2 and U-2 × U-1 hybrids developed from parthenogenetic clone-line breeds were compared with those of the commercial hybrid Ipakchi-1 × Ipakchi-2.

Table 2.

Technological characteristics and cocoon filament quality indicators of industrial silkworm hybrids developed from parthenogenetic clone-line breeds (2021–2026)

No.	Hybrids	Years	Dry cocoon weight per cocoon, g	Silk yield, %	Metric number (m/g)	Reelable filament length, m	Total cocoon filament length, m
1	U-1 x U-2	2021	0.618	52.07	3690	1037	1137
		2022	0.820	50.00	3521	1042	1250
		2023	0.718	50.35	3636	1058	1258
		2024	0.850	52.63	4098	1108	1567
		2025	0.859	48.43	3690	1162	1516
		2026	0.678	51.22	4000	1317	1417
		X̄±Sx	**0.766±0.03**	**50.1±1.2**	**3541±151**	**1183±76**	**1236±69**
		Cv, %	8.8	6.3	10,4	15.7	13.7
		Relative value, %	109.4	104.2	105,7	118.3	123.6
2	U-2 x U-1	2021	0.810	52.31	3425	1058	1292
		2022	0.754	51.62	3145	1087	1283
		2023	0.698	50.29	3484	1296	1396
		2024	0.750	51.74	3953	1117	1208
		2025	0.809	51.56	3390	1220	1521
		202	0.687	53.38	3558	1192	1292
		X̄±Sx	**0.759±0.05**	**48.8±0.9**	**3704±128**	**1162±37**	**1270±71**
		Cv, %	16	4.4	8.5	16.0	13.7

		Relative value, %	108.4	101.5	110.6	116.2	127
3	Ipakchi-1 × Ipakchi-2 (Control)	**2021–2026 average**	**0.700±0.06**	**48.06±1.2**	**3350±160**	**1000±75**	**1000±78**
		Cv, %	**16.7**	**6.9**	**11.8**	**16.5**	**18.2**
		Relative value, %	**100**	**100**	**100**	**100**	**100**

The results revealed significant differences among the studied hybrids in terms of technological characteristics. The U-1 × U-2 hybrid demonstrated the highest dry cocoon weight (0.766±0.03 g), exceeding the control hybrid by 9.4%. Silk yield reached 50.1±1.2%, which was 4.2% higher than that of the control. In addition, the reelable filament length of this hybrid averaged 1183±76 m, representing an increase of 18.3% over the control hybrid.

The U-2 × U-1 hybrid showed superior performance in metric number and total cocoon filament length. The average metric number reached 3704±128 m/g, exceeding the control by 10.6%. Since a higher metric number indicates a finer and more valuable silk filament, this result confirms the technological superiority of the U-2 × U-1 hybrid. The total cocoon filament length averaged 1270±71 m, which was 27.0% higher than that of the control hybrid.

The coefficients of variation for most technological traits were lower or comparable to those of the control hybrid, indicating satisfactory stability of the newly developed hybrids. The relatively low variation in silk yield (4.4–6.3%) further demonstrates the uniformity of the experimental materials.

Overall, the results indicate that both reciprocal hybrids possessed superior technological characteristics compared with the commercial control. The U-1 × U-2 hybrid was distinguished by higher silk yield and reelable filament length, whereas the U-2 × U-1 hybrid exhibited finer silk filament and greater total filament length. These findings confirm that the use of parthenogenetic clone-line breeds contributes not only to improved biological productivity but also to enhanced technological quality of industrial silkworm hybrids.

Conclusion

1.Reciprocal hybrids developed from parthenogenetic clone-line breeds surpassed the control hybrid in most biological and technological traits.

2.The U-2 × U-1 hybrid showed the highest larval viability (94.6%), cocoon weight (1.80 g), cocoon shell weight (426.2 mg), and silk ratio (24.0%).

3.The U-1 × U-2 hybrid exhibited superior silk yield and reelable filament length, while U-2 × U-1 demonstrated the highest metric number and total filament length.

The obtained results confirm the breeding value of parthenogenetic clone-line breeds and indicate that the U-2 × U-1 hybrid is a promising commercial hybrid for modern sericulture.

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