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RESEARCH ARTICLE

Performance of Hybrids of Silkworm, Bombyx mori L. in Different Districts of Tamil Nadu

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ABSTRACT

Investigations were undertaken to assess the performance of new bivoltine hybrid (CSR46 X CSR47), double hybrid [(CSR6 X CSR26) X (CSR2 X CSR27)] and bivoltine hybrid (CSR2 X CSR4) along with cross breed (PM X CSR2) in five districts of Tamil Nadu, namely Coimbatore, Salem, Dharmapuri, Pudukkottai and Tirunelveli . The result showed that double hybrid recorded significantly highest economic traits, *viz.,* cocoon weight, shell weight, shell ratio, filament length and filament weight. The denier of double hybrid was also found to be significantly finer than all other hybrids tested. Significant difference in economic traits existed between silkworm hybrids and for the same hybrid in their performance in different districts in the present study.

Keywords: Silkworm, bivoltine hybrids, cross breed, silkworm-growing districts of Tamil Nadu.

INTRODUCTION

Sericulture, an agro-based cottage industry, could be realized as a viable proposition through successful cocoon production with the exploitation of superior breeds for continuous rearing. Internationally, the silk is classified into different grades starting from “4A” (superior grade) to “H” (lower grade) based on the quality. The silk produced in China, Japan and South Korea fall under superior grades (4A) whereas the multivoltine based Indian silk is graded as lower grade (H) in the international market. Bivoltine breeds, on the other hand possess higher filament length of more than 1000 m per cocoon with finer denier and superior quality (Somashekar, 1994).

India has a strong sericultural base with enormous potential for boosting silk production. The stability of silkworm crop was not achieved mainly due to climate, rearing technology and socio-economic conditions. With the advent of new technology of silkworm rearing in tropics, the situation changed and use of multivoltine x multivoltine crosses have been replaced by multivoltine x bivoltine and bivoltine x bivoltine hybrids (Datta, 1984). If India has to compete in the international market successfully, it is necessary to improve the quality of silk yarn produced in the country. By improving the technology of silk reeling and processing, the quality of multivoltine x bivoltine silk can be improved marginally. But, production of raw silk of international grade is possible only through introduction of new bivoltine silkworm hybrids and double hybrids. This has necessitated evolution and evaluation of new silkworm bivoltine hybrid for increased cocoon and gradable raw silk production.

Lot of emphasis is given for bivoltine raw silk production on account of higher returns due to quality. This has resulted in rearing of pure bivoltine breeds and their single cross hybrids. Hybrids, in general, are superior to parental breeds in growth, vigour and other economic traits (Ashoka and Govindan, 2011). Suitable bivoltine hybrids and double hybrids with very good production traits for commercial exploitation were identified which could be popularized in India. In spite of the advantages, double hybrid rearing is lesser in India as in Japan and China.

The reports by various earlier researchers (Naseema Begum *et al*. 2005; Dandin *et al.* 2005; Chandrasekar *et al.,* 2011; Subbarao *et al.*, 2011 and Nirmal Kumar, 2011) indicated that the bivoltine hybrids and double hybrids performed superiorly than the cross breed and recorded significantly increased economic characters such as larval weight, cocoon weight, shell weight, shell ratio, filament length and yield. However, the detailed information is not available on the performance of CSR hybrids including double hybrids in Tamil Nadu. Hence, an attempt was made with the objective of assessing the cocoon and reeling traits of bivoltine hybrids and double hybrid over cross breed.

MATERIALS AND METHODS

Hybrids and locations

The study was conducted to assess the performance of new bivoltine hybrid (CSR46 X CSR47), double hybrid [(CSR6 X CSR26) X (CSR2 X CSR27)] and bivoltine hybrid (CSR2 X CSR4) in Coimbatore, Salem, Dharmapuri, Pudukkottai and Tirunelveli districts of Tamil Nadu. The crossbreed silkworm (PM X CSR2), which is popular among the farmers of Tamil Nadu was used as the standard check for comparison.

Sample collection and observation

One kilogram cocoon each of bivoltine hybrid, double hybrid and cross breed were randomly collected from the farmers holdings located in five different places in each of the selected five districts. The collected cocoons were brought to the laboratory of Department of Sericulture, Forest College & Research Institute, Mettupalayam immediately for recording observations. Each of five places is considered as the replication. The average weight of cocoon was recorded by randomly selecting 100 cocoons from each replication. Then, the cocoons were cut open separately replication wise and the average cocoon weight was observed. The shell ratio was worked out by following the formula.

$$\text{Shell ratio} = \frac{\text{Shell weight}}{\text{Cocoon weight}} \times 100$$

From each replication, 25 cocoons were randomly selected which were stifled, cooked and reeled with Euprovette (Single cocoon reeler) (Thanga roja, 2018). The average silk filament length was recorded. The silk filament was oven dried at 70 ^{0}C for one hour to arrive at standard moisture content (Anonymous, 2003), and average weight was recorded. The denier was worked out with the following formula.

$$\text{Denier} = \frac{\text{Filament weight}}{\text{Filament length}} \times 9000$$

The data collected were statistically analyzed under Factorial Completely Randomized Design (FCRD) as described by Panse and Sukatme (1967).

RESULT AND DISCUSSION

The investigations showed that the bivoltine hybrids performed superiorly to the cross breed which is commercially reared throughout the Southern states, particularly Tamil Nadu. The result of the investigations has been given detailed hereunder.

1. Cocoon weight

The performance of different hybrids varied greatly. Among the different hybrids studied, the double hybrid recorded a significantly higher cocoon weight of 1.91 than all other hybrids (Fig. 1). This was followed by CSR46 X CSR47 (1.86 g) and CSR2 X CSR4 (1.81 g). The lowest cocoon weight of 1.68 g was recorded in PM X CSR2. The performance of different hybrids did not show significant variation in different districts. However, a maximum cocoon weight of 1.84 g was observed in a double hybrid at the Coimbatore district. In the interaction between hybrids and districts, the significantly highest cocoon weight (1.95 g) was observed in double hybrid at Coimbatore which was found to be on par with CSR46 X CSR47 (1.90 g). The minimum cocoon weight of 1.66 g was registered in PMxCSR2 at Tirunelveli.

The result of the present study is substantiated by the findings of Govindan *et al.* (1990) and Nirmal Kumar *et al*. (1998), who observed maximum cocoon weight in double hybrid than the single hybrid. The present observations also fall more or less in line with the findings of Suresh Kumar *et al.* (2011), who recorded a significantly higher cocoon weight of 1.63 g in double hybrid than a single hybrid (1.49 g) when the silkworm rearing was taken up under high temperature and high humidity conditions in tropics. Variation in cocoon weight was observed between districts. The present result is strengthened by Senguptha *et al*. (1971), who reported that the performance of silkworms is known to vary to a greater extent in different agro-climatic conditions.

2. Shell weight

Shell weight is an important trait for high productivity, which can be mostly achieved by the heterosis effect. Irrespective of districts, the double hybrid performed well, recording the highest shell weight of 0.47 g, which was found to be statistically superior over all other hybrids (Fig. 2), followed by CSR46 X CSR47 (0.43) and CSR2 X CSR4 (0.35 g). PM X CSR2 recorded the lowest shell weight of 0.29 g. Among the different districts, the highest shell weight of 0.40 g was observed in Pudukkottai followed by Coimbatore (0.39 g) and Tirunelveli (0.39 g), which were found to be statistically on par with each other. The lowest shell weight of 0.37 g was observed in Dharmapuri. In the interaction between hybrids and districts, the significant maximum shell weight of 0.48 g was registered in a double hybrid at Coimbatore. This was found to be statistically on par with double hybrid in all other districts. Here, all other hybrids were found to be statistically inferior when compared to double hybrid. The minimum shell weight of 0.28 g was recorded in Salem and Tirunelveli.

The difference in shell weight in the present study might be due to the variation in environmental conditions as Suresh Kumar (2005) reported. The present result agrees with Sohn and Ramirez (1999), who observed that double hybrid showed the higher weight of cocoon shell compared to single and three-

way crosses. Further, Zita *et al*. (2003) reported lesser shell weight in PM X CSR2, which supports the present findings. A maximum shell weight of 0.452 g was recorded in double hybrid reared under high temperature and high humidity, which was statistically superior over CSR2 X CSR4 (0.427 g) (Seshagiri *et al.*, 2016). This finding also strengthens the present observations.

3. Shell ratio

Shell ratio is a very important factor, which is considered one of the main breeding objectives for silkworm breeders. Irrespective of districts, the highest shell ratio of 24.42 percent was recorded in double hybrid followed by CSR46 X CSR47 (23.31%) and CSR2 X CSR4 (19.23 %) (Fig. 3). PM X CSR2 recorded the significant lowest shell ratio of 17.14 percent. In the case of shell ratio between districts, it was observed that Pudukkottai registered the highest shell ratio of 21.71 percent, which was found to be statistically on par with Tirunelveli (21.08 %). Salem was found to have the least shell ratio of 20.75 percent, which did not differ statistically from Dharmapuri and Coimbatore. The interaction effect between the hybrids and districts showed that double hybrid in Coimbatore was found to register significantly highest shell ratio of 24.62 percent. PM X CSR2 at Salem recorded significantly lowest shell ratio of 16.67 per cent over all other treatments.

These observations were strengthened by the findings of Mal Reddy *et al*. (1998) and Suresh Kumar *et al*. (2006), who reported a shell ratio of more than 23 per cent in bivoltine hybrids. Fotadar *et al*. (1999) have carried out many field trials in traditional sericulture districts and reported the superiority of CSR hybrids over the crossbreed, which also confirms the present findings. The present results are further substantiated with the findings of Suresh Kumar *et al.* (2011), who observed a significantly higher shell ratio (22.38 %) in double hybrid than single hybrid (20.50 %) in an attempt to develop double hybrid tolerant for high-temperature condition prevailing in tropics.

4. Silk filament length

There is a great variation in the length of silk filament among different hybrids and districts studied (Fig. 4). Among the various hybrids, the double hybrid recorded the highest silk filament length of 1384.60 m, which was found to be statistically superior overall other hybrids. This was followed by bivoltine hybrid, CSR46 X CSR47 (1281.80 m) and CSR2 X CSR4 (1188.80 m). Significantly lowest silk filament length of 967.60 m was recorded in PM X CSR2. Among the different districts, the highest silk filament length of 1242.25 m was observed in Salem which was followed by Dharmapuri (1213.00 m), Pudukkottai (1211.75 m), and Tirunelveli (1198.75 m), which were found to be statistically on par. Significantly lowest silk filament length of 1162.75 m was observed in Coimbatore. In the interaction between hybrids and districts, the significantly highest silk filament length of 1401 m was observed in a double hybrid at Coimbatore. This was found to be statistically on par with double hybrid in all other districts and CSR46 X CSR47 in Dharmapuri (1311 m) and Salem (1301 m). The least silk filament length 973 m was observed in PM X CSR2 in Pudukkottai.

The present results fall in line with Babulal *et al*. (2005), who found that bivoltine hybrids recorded longer filament lengths than crossbreeds. Dayananda *et al.* (2011) recorded significantly increased filament length by 18.13 per cent in double hybrid over the single bivoltine hybrid. Lakshmanan and Suresh Kumar (2012) observed variation in the length of silk filament between different hybrids, *viz.,*

CSR50 X CSR51, D2 X D13 and DNB7 X CSR2. These findings further strengthen the present observations. The findings of Munemanik *et al.* (2018), who recorded significantly higher silk filament length (999.33 m) in double hybrid, (CSR2 × CSR27) × (CSR6 × CSR26) than in the bivoltine hybrid, CSR50 X CSR51 (938.33 m) also confirm the present results.

5. Silk filament weight

Irrespective of district, double hybrid and CSR46 X CSR47 performed well recording maximum silk filament weight of 0.363 g, which was found to be statistically superior over CSR2 X CSR4 (0.344 g) and PM X CSR2 (0.299 g) (Fig. 5). Among the five districts studied, Dharmapuri recorded highest silk filament weight of 0.351 g, which was found to be statistically on par with all other districts except Coimbatore which registered lowest silk filament weight of 0.334 g. The interaction between the hybrids as well as districts revealed that significant maximum filament weight of 0.373 g was observed in double hybrid in Coimbatore, which was found to be statistically on par with CSR46 X CSR47 in Dharmapuri (0.372 g) and Salem (0.368 g), double hybrid in Tirunelveli (0.364 g) and CSR2 X CSR4 in Dharmapuri (0.363 g). Significantly lowest filament weight was observed in PM X CSR2 in Pudukkottai (0.295 g). The present observations can be corroborated with the findings of Babulal *et al.* (2005), Dayananda *et al.* (2011), and Lakshmanan and Suresh Kumar (2012), who reported significantly enhanced silk filament weight in bivoltine hybrids than crossbreed. The present study also shows that there is variation in performance of breeds in different districts. These results fall in line with the findings of Sengupta *et al*. (1971), who observed a significant variation in the performance of silkworms in different agro-climatic conditions.

6. Denier

Denier is one of the main characteristics of raw silk, as uniform filament size results in better weaving efficiency by reduction in breakages. Among the different hybrids tested, the double hybrid recorded the lowest denier of 2.37, which was found to be statistically superior over all other hybrids (Fig. 6). This was followed by bivoltine hybrids, CSR46 X CSR47 (2.56) and CSR2 X CSR4 (2.80). PM X CSR2 recorded significantly the highest denier of 3.16. The thickness of silk filament was significantly altered in different silkworm hybrids in various districts. Salem registered the lowest denier of 2.62, which was found to be statistically on par with Dharmapuri (2.67) and Pudukkottai (2.72). The highest denier of 2.84 was observed in Tirunelveli. In the interaction effect between hybrids and districts, significant minimum denier of 2.36 was observed in double hybrid in Coimbatore. This was found to be on par with double hybrid in all other districts and CSR46 X CSR47 in Salem, Pudukkottai and Tirunelveli. Significantly maximum denier of 3.64 was observed in Tirunelveli district in PM X CSR2.

The result of the present study is strengthened by the works of Halliyal *et al*. (1998), who reported significantly longer filament length and finer denier with less denier variation in bivoltine hybrids. The present result also aligns with Babulal *et al.* (2005), who reported that bivoltine hybrids recorded fine denier than crossbreed. Further, Suresh Kumar *et al.* (2011) recorded the fine denier of 2.45 in double hybrid reared in tropical condition, which was found to be statistically superior over single hybrid (2.74). This finding can be corroborated with the present observations. In the present study, variation in denier was observed between hybrids reared in different districts and this was supported by Toyoma (1906), who

observed that denier of silk filament is not only dependent on the genetic potential of silkworm races but also on the climatic conditions in which they are reared.

CONCLUSION

It is concluded from the present study that double hybrid showed superior performance statistically in the economic characters such as cocoon weight, shell weight, shell ratio, filament length, filament weight and denier over other hybrids namely CSR46 X CSR47, CSR2 X CSR4 and cross breed, PM X CSR2. It is also inferred from the available data that the tested silkworm hybrids and cross breed showed significant variation in their performance in terms of economic characters in each district .

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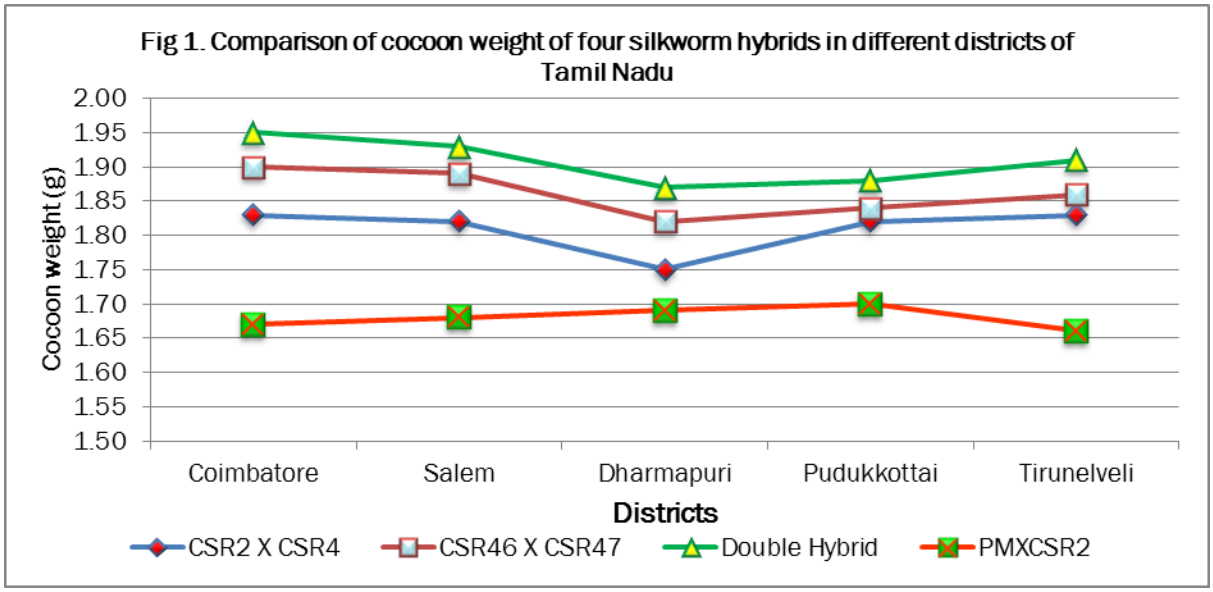

Fig 2. Comparison of shell weight of four silkworm hybrids in different districts of Tamil Nadu

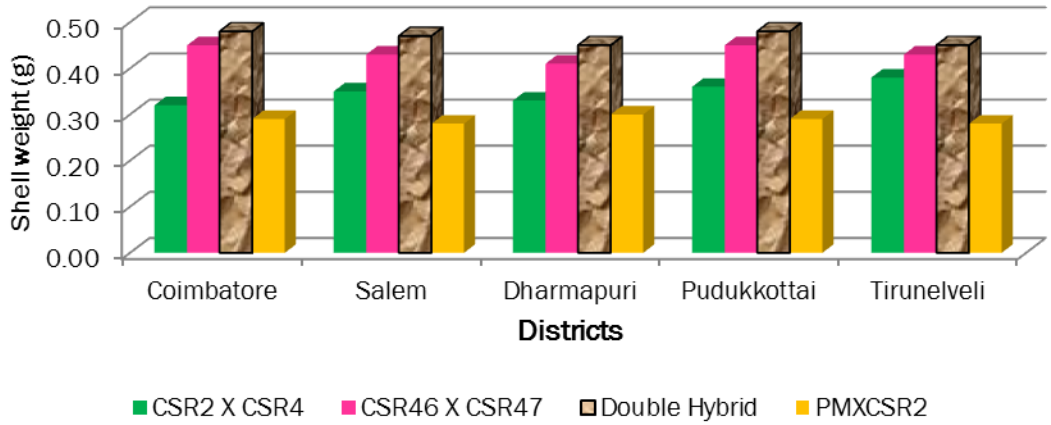

Fig 3. Comparison of shell ratio of four silkworm hybrids in different districts of Tamil Nadu

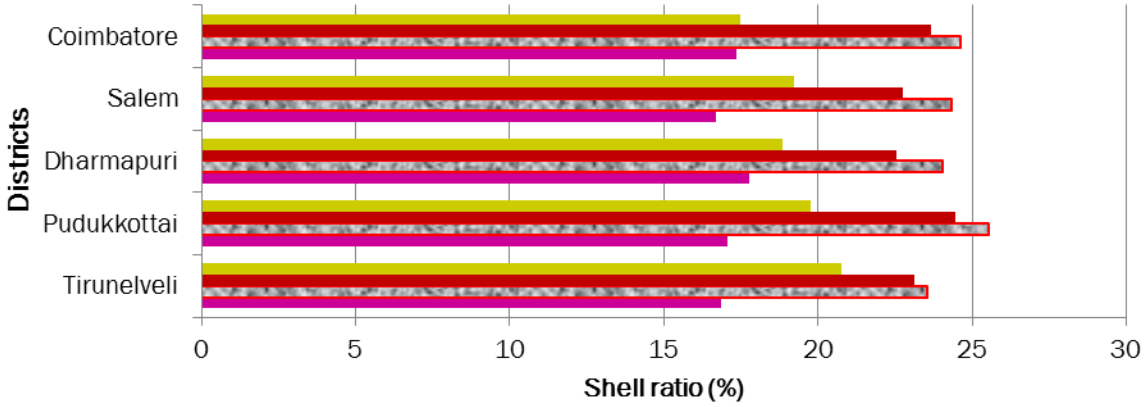

Fig 4. Comparison of filament length of four silkworm hybrids in different districts of Tamil Nadu

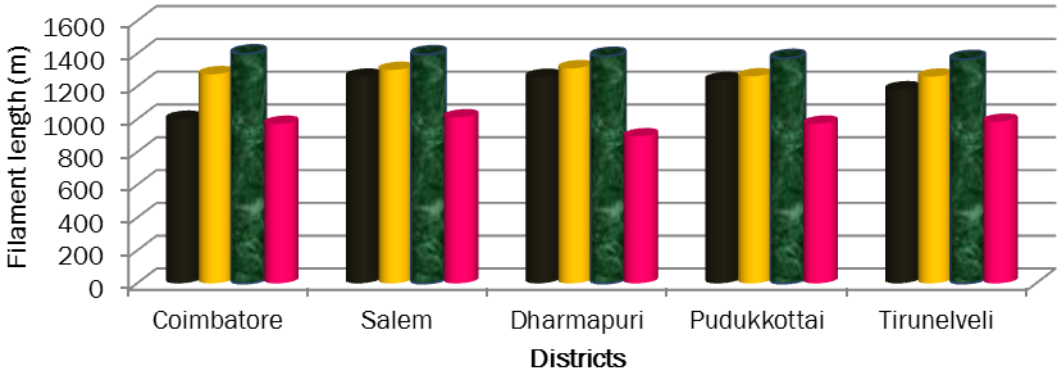

Fig 5. Comparison of filament weight of four silkworm hybrids in different districts of Tamil Nadu

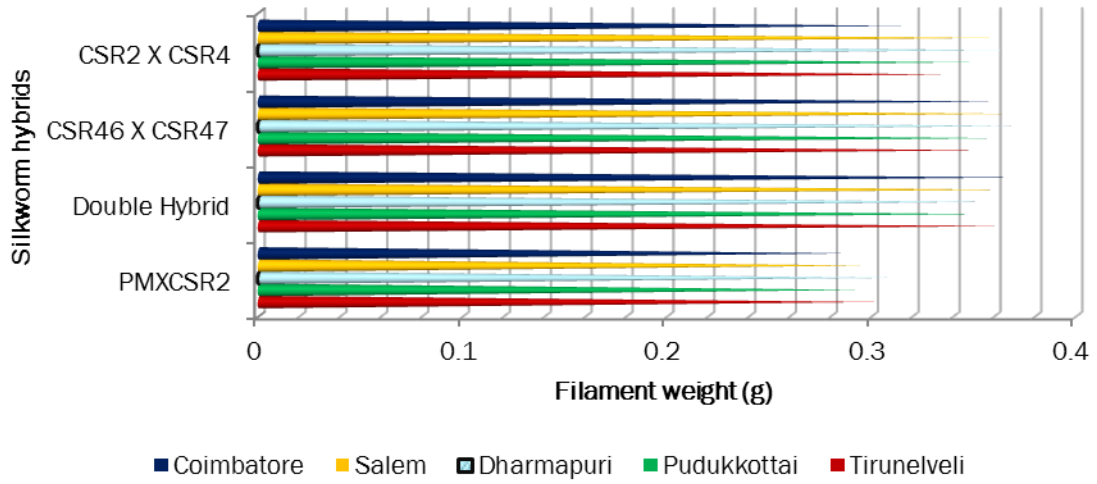

Fig 6. Comparison of denier of four silkworm hybrids in different districts of Tamil Nadu