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A STUDY ON ECONOMICAL PARAMETER OF SILKWORM, *BOMBYX MORI* (L.) SUPPLEMENTED WITH AZOLLA

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Abstract: Silkworms are a highly domesticated and economically important insect which is the primary producer of silk. Silk is a fibrous protein of animal origin. *Bombyx mori*. The mulberry silkworm is included in the order Lepidoptera of class Insecta. It is a monophagous species, which is exclusively reared on mulberry plant. The quality and quantity of mulberry leaves along with environmental factors affect production of raw silk. *Azolla* is an aquatic fern, floats on water surface. It grows in association with blue green algae (*Anabaena azollae*) which is responsible for the fixation and assimilation of atmospheric Nitrogen. *Azolla*, in turn provides the Carbon source and favourable environment for the growth and development of the algae. *Azolla* is rich in proteins, essential amino acids and minerals like Calcium, Potassium, Phosphorus, Iron, Copper, Magnesium and Vitamins. Fortification of *Azolla* concentrations along with mulberry leaves *viz*., 5%, 10%, 15% and 20% has an impact on silkworms larval and cocoon traits. 20% *Azolla* treated silkworms significantly improved all the parameters compared to others. From this study, it may be concluded that *Azolla* application can enhance the economic status and increases the yield in sericulture.

Keywords: *Anabaena azollae*, *Azolla*, *Bombyx mori*, mulberry.

1. INTRODUCTION:

Sericulture plays a very important role in sustainable development of India by providing valuable products. Sericulture is a labour-intensive industry. The Sericulture practises includes two major activities namely cultivation of mulberry and rearing of silkworms to produce the cocoons for the silk reeling industry (Simi Simon and Asiya Nuzhat, 2022). *Bombyx mori*, L is an important economic insect is being used as a tool to convert mulberry leaf protein into silk. India is the largest producer of silk in the world with an annual mulberry silk production of 20478 MT (Anon, 2016; Shruthi Ashok *et al*. 2019). Silk production is dependent on the larval nutrition and nutritive value of mulberry leaves, which plays a very important role producing good quality cocoons (Legay, 1958). In addition to mulberry leaves, feed supplements are also given to silkworm to enhance economic characteristics (Jayapaul, 2003; Sheeba, 2006). The term *Azolla* combines two Greek words 'Azo' (to dry) and 'Allyo' (to kill), reflecting plants failure to thrive under dry circumstances (Lumpkin and Plucknet, 1982). The blue green algae (*Anabaena azollae*) grow in symbiotic association with *Azolla*. The algae fixes Nitrogen as high as 3~5 kg per day provides sufficient Nitrogen for itself and host, meanwhile *Azolla*, provides a protected environment for the algae and supplies it with a fixed Carbon source (Peter, 1976). The higher crude protein content (above 20%) and presence of essential amino acids (high lysine content) made *Azolla* relevant for livestock, poultry and fish farmers (Giridhar, 2012). Due to easy cultivation, good nutritive value and high productivity it can be used as food supplement to silkworms. The success of quality of cocoon crop depends exclusively on the nutrition of silkworm (Nagesh and Deviah, 1996). Thus the present study was conducted to analyse the impact of *Azolla* on larval and cocoon traits of silkworms.

2. Materials and Methods :

Silkworm Rearing: The present study was carried out at Zoology Research Lab, Tumkur University, Tumakuru. CSR2 × CSR4 breed of silkworm were reared under laboratory conditions of 25±3℃, 72±2% relative humidity. The larvae were divided into 3 groups; each group has 20 larvae which were supplied with sufficient amount of mulberry leaves. The leaves were always cleaned and washed from dust and were given to the 4th and 5th instar larvae, at two intervals. The larvae were reared under standard rearing conditions (Krishnaswami, 1973).

Supplementation of Azolla: *Azolla* was made into different concentrations 5%, 10%, 15% and 20% and treated with mulberry leaves and fed to silkworms twice a day from fourth instar first day till they reached spinning stage.

Economic parameter: The *Bombyx mori* species was assessed based on larval weight, larval duration, cocoon weight, pupa weight, shell weight, shell ratio and silk production ratio. The larval length was measured using scale. The Larval weight, shell weight and cocoon weight were measured using an electronic balance (Harendra Kumar *et al*. 2013; Waktole Sori *et al*. 2012). Shell ratio and silk production ratio was calculated using formula (Harendra Kumar *et al*. 2013).

3. Statistical Analysis :

The given data were analyzed by two way analysis of variance (ANOVA) followed by Dunnett's Multiple comparisons test, using a commercially available statistics software package (Graph pad Prism 8for windows). Results were presented as Mean±SD. P values < 0.001 were regarded as statistically significant.

Results

The economic parameter was observed in CSR2 × CSR4 breed of silkworm under study which larval weight, larval duration, cocoon weight, pupa weight, shell weight, shell ratio and silk production ratio. The economic parameter of CSR2 × CSR4 breed of silkworm from 4th and 5th instar are given in Table 1, 2 & 3 and figure 1, 2 & 3. The table 1 and figure 1 summarizes the larval duration of CSR2 × CSR4 breed of silkworm feeding on mulberry leaves supplemented with *Azolla*. Larval duration shows low in both 4th and 5th instar larvae treated with (P value < 0.001) 20% *Azolla* and the high in control. The larval weight gained by silkworms treated with 20% *Azolla* shows high value in 4th and 5th instar larvae and least in control. Data presented in table 2 and figure 2 indicates the cocoon weight shows highest in silkworms treated with 20% *Azolla* and least in control. Pupa weight is highest in silkworms treated with 20% *Azolla* least in control. Shell weight is highest in silkworms treated with 20% *Azolla* least in control. The table 3 and figure 3 summarizes the Silk production ratio shows maximum (P value < 0.001) in control compared to others. Shell ratio indicates maximum in control compared to others.

Table 1: Effect of different concentrations of *Azolla* on Larval weight and larval duration in CSR2 × CSR4 race of *Bombyx mori*. L. The values are expressed in grams for larval weight and days for larval duration during IV instar and V instar**.**

Concentrations of *Azolla*	Larval weight (g)		Larval Duration (days)	
	IV Instar	V Instar	IV Instar	V Instar
Control	6.87±0.01	26.3±0.03	5.1±0.01	8.16±0.03
5%	7.23±0.01	28.28±0.28	4.5±0.02	7.5±0.12
10%	8.03±0.04	29.57±0.09	4.3±0.04	7.16±0.09
15%	9.14±0.02	30.09±0.04	4.1±0.01	6.8±0.05
20%	10.24±0.02	31.25±0.29	3.6±0.02	6.6±0.23

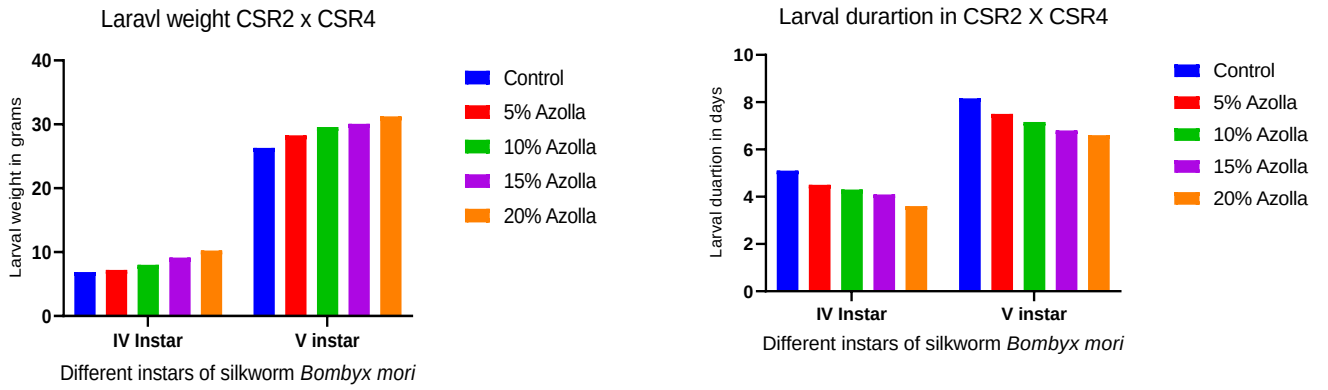

Fig 1: Larval weight and larval duration in CSR2 × CSR4 race of *Bombyx mori*. L fed ad libitum *Morus alba* treatment of *Azolla* during IV instar and V instar.

Table 2: Effect of different concentrations of *Azolla* on Cocoon weight, Pupa weight, Shell weight in CSR2 × CSR4 race of *Bombyx mori*. L. The values are expressed in grams during IV instar and V instar**.**

Concentrations of *Azolla*	Cocoon weight (g)	Shell weight (g)	Pupa weight (g)
Control	7.03±0.04	1.47±0.2	5.56±0.18
5%	8.77±0.01	1.63±0.02	7.14±0.026
10%	9.13±0.02	1.69±0.01	7.44±0.03
15%	9.28±0.04	1.72±0.07	7.56±0.04
20%	9.59±0.03	1.79±0.01	7.80±0.02

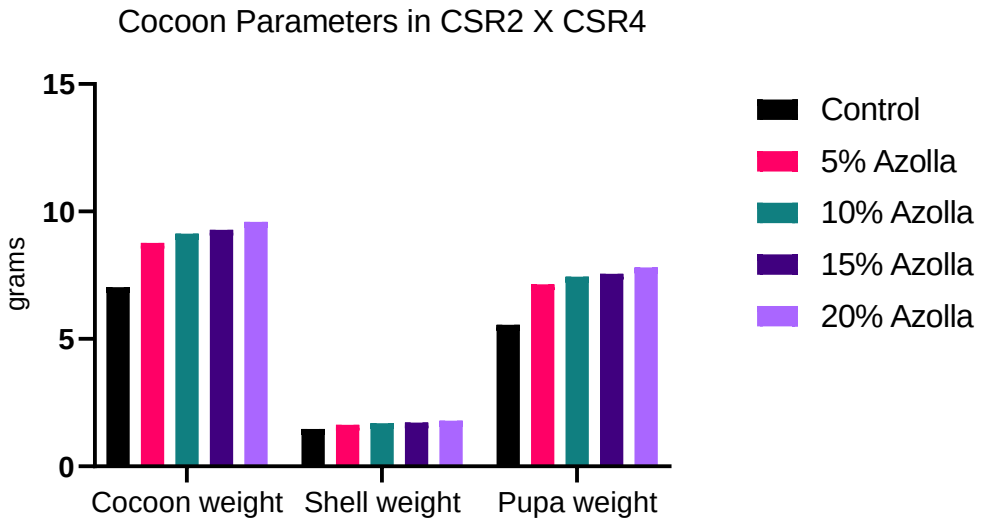

Fig 2: Cocoon Parameters in CSR2 × CSR4 race of *Bombyx mori*. L fed ad libitum *Morus alba* treatment of *Azolla* in V instar

Table 3: Effect of different concentrations of *Azolla* on shell ratio and silk production ratio in CSR2 × CSR4 race of *Bombyx mori*. L. The values are expressed in percentage for silk production ratio and shell ratio during V instar.

Concentrations of *Azolla*	Shell Ratio (%)	Silk production ratio (%)

Control	20.91	26.43
5%	18.58	22.82
10%	18.51	22.71
15%	18.53	22.75
20%	18.66	22.94

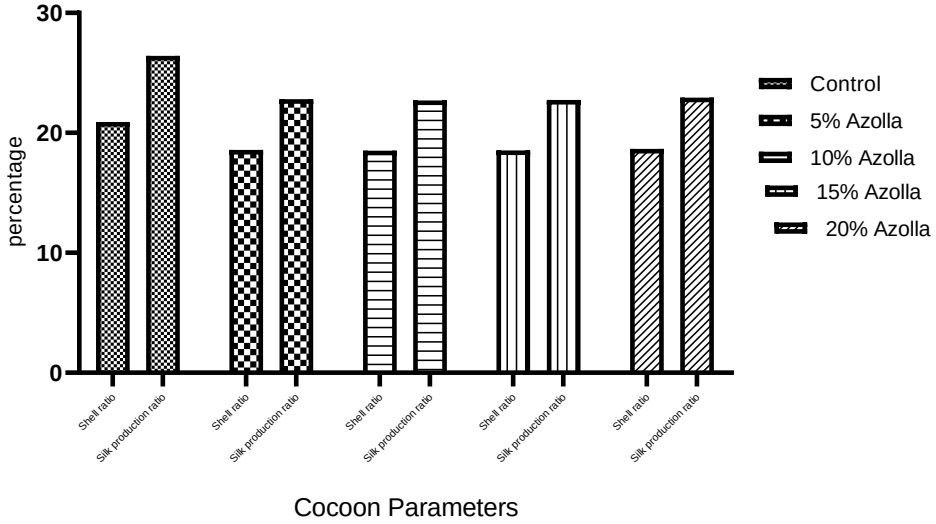

Fig 3: Silk production ratio and Shell ratio in CSR2 × CSR4 race of *Bombyx mori*. L fed ad libitum *Morus alba* treatment of *Azolla* in V instar

4. Discussion :

The present study revealed that the supplementation of *Azolla* to the mulberry leaves for silkworm *Bombyx mori* CSR2 × CSR4 exhibited significant results on economic parameters like growth (larval duration, larval weight), cocoon (cocoon weight, shell weight, pupa weight, shell ratio) and post cocoon (silk production ratio) variables. This result indicates that a mulberry leaves with *Azolla* shows better outcome in all the stages of silkworm. The larval parameters were greatly influenced by the nutritive contents of mulberry leaves and the supplements. Mulberry leaves supplemented with 20% *Azolla* shows higher larval weight when compared to control, it may be due to the fact that *Azolla* is a rich source of protein (25-30%), essential amino acids (7-10%) and minerals (10-15%) (Vijakumar *et al*.2016). Highest larval weight leads to higher silk production (Venugopal Reddy Bovilla, 2015). Significant shorter larval duration was observed when mulberry supplemented with *Azolla*, this attributed to the assumption that the worms nutritive requirement might have been fulfilled within lesser duration because of feed supplementation as compared with unsupplemented mulberry leaves (Roy Choudhary *et al*. 1994; Vijakumar *et al*. 2016). The cocoon weight, shell weight, shell ratio, silk production ratio depends on the rearing conditions, quality, nutritive elements and quantity of the mulberry leaves supplied during rearing, higher the weight indicates the approximate quantity of raw silk output. *Azolla* has proteinaceous source can enhance the cocoon and shell weight (Vijakumar et al. 2016). The current study substantiates the observations of earlier reports on the Implementation of *Azolla* in sericulture.

5. Conclusion :

In the present study it has observed that the V instar larva of silkworm *Bombyx mori* CSR2 × CSR4 shows high yield in economical parameters such as larval weight, cocoon weight, pupa weight, shell weight, silk production ratio, shell ratio, larval duration. This is because CSR2 × CSR4 is a bivoltine hybrid breed has better seed crop performance and higher seed recovery and has best crop stability. The current study shows the importance of supplementation of *Azolla* on economical traits of silkworms.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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