# EFFECT OF COOPERATIVE HOUSE REARING AND TRANSPORTATION ON GROWTH AND ECONOMIC COCOON CHARACTERS OF *BOMBYX MORI* L.

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## Abstract

The influences of young age cooperative house rearing conditions (27-28℃, 80-90%, RH) and their transportation vis-à-vis conventional rearing method on silkworm growth and economic cocoon traits was assessed. Besides, different transportation modes and means were evaluated. The results revealed that the young age larvae of C-102 strain reared under cooperative house conditions and transported by motorbike gave 5.12% (larval body weight gain), 11.34% (cocoon weight) and 12.69% (shell weight) more than conventional methods of rearing. In case of 206-PO, return of larval body weight gain, cocoon and shell weight were 8.15%, 11.76% and 9.56% higher, respectively. Larvae transported in wax paper lost larval body weight by 4.24% (C-102) and 4.09% (206-PO) as compared to wooden rearing tray. Combination of motorbike and wooden rearing tray produced maximum larval body weight (3.23g $l^{-1}$), cocoon weight (1.53g), shell weight (0.32) and cocoon shell ratio (22.32%) in C-102 while in 206-PO these entities have values of 3.371g$l^{-1}$, 1.358g, 0.287g and 22.95% in the same combination. Based on present findings it is recommended that young age worms should be reared under cooperative house conditions and transported by motorbike-wooden rearing tray for better growth, cocoon production and consequently more economic returns.

**Key words:** Silkworm, Cooperative house rearing, Chawki, Transportation Modes, Growth, Cocoon characters

## Introduction

Many factors contribute to the success of silkworm rearing particularly on quality of cocoon crop. Apart from the diseases, physico-trophic rearing conditions have paramount influence on growth and economic cocoon traits. Each successive developmental stage requires different rearing package as well as affect subsequent stages. For instance, optimum temperature and relative humidity for young age larvae (1$^{st}$ & 2$^{nd}$ instars) is 27-28℃ and 80-90%, respectively while for adult age larvae (4$^{th}$ &5$^{th}$ instars) the thermo-hygro conditions are 22-24℃ and 70-75% (Ito and Kobayashi, 1978; Ullal and Narasimhanna, 1978; Krishnaswami, 1986). Similarly, nutritional requirements of young and adult age worms vary. Young age larvae need more carbohydrates in

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addition to protein compared to adult age when more protein is necessary (Kumar and Benchamin, 1990). Furthermore, young worms are less resistant to pathogenic microbes than grown ones therefore, more hygienic conditions are to be maintained during early stadia (Singh and Saratchandra, 2004).

Sensitivity of young age worms requires highly trained man power and infra-structure. Often both are wanting at farmer level. This is one of the principal impediments in maximization of returns. To smother this problem and supply healthy and robust worms to farmers, cooperative house rearing (CHR) also named chawki rearing centers were established back in 1970s in sericulturally advanced countries (Benchamin & Nagaraj, 1987; Benchamin, 1989; Aruga, 1994). These houses were equipped to rear twenty million or more larvae up to the end of $2^{nd}$ and/or partially to end of $3^{rd}$ instar. This saved expenses and increased cocoon crop. Gupta *et al*. (1986) reported 35 percent more cocoons in case of supply of $2^{nd}$ instar larvae produced by chawki rearing centre than by traditional methods of rearing. Likewise, an increase of 6-7kg of cocoons/100dfls was recorded for larvae brushed in CHR over direct brushing at rears' place (Jolly, 1986).

Silkworms reared in cooperative houses are transported to sericulturists by using various transportation modes (head load, bicycle, motorbike, etc.) and means (wax paper, hard card box, wooden rearing trays, etc.). These transportation modes and means have variable impact on silkworm growth and cocoon yield. Hence there is a need to develop module of efficient transportation modes and means.

In Pakistan there is a dearth of work on the effect of young age transportation of silkworm growth and economic cocoon characters. Present study therefore, was undertaken to assess the effects of cooperative house rearing side by side different transportation modes, means and their interaction on silkworm growth and economic cocoon traits.

## Materials and Methods

Two Chinese bivoltine pure line strains (C-102 and 206-PO) of *Bombyx mori* L. were reared under cooperative house rearing conditions (27±1℃ and 85±5% RH). Neonates were reared following covered method up to $2^{nd}$ molting. After first feed of $2^{nd}$ molt 450 larvae per treatment were selected at random from stock culture of the same bed and weighed. Weighed worms were transported for a constant time lapse of 60 minutes by four modes, *viz*. head load (5km), bicycle (10km), motorbike (20km) and public wagon (25km). In addition, there were three transport means namely wooden

rearing tray-WRT (30x15x4cm), hard card box-HCB (15x12x5cm) and wax paper-WP in each transportation mode. Worms were brought back in the laboratory and reared at 25±1℃, 80±5%RH ($3^{rd}$ instar), 24±1℃, 75±5%RH ($4^{th}$instar) and 23±1$^{o}$C, 70±5%RH ($5^{th}$instar). A control was maintained in the laboratory where worms were brought up through out under farmer level conditions (25±1℃, 65±5% RH). Larval growth was measured in terms of larval body weight gain (LBWG) thus worms were weighed again on $4^{th}$ and $15^{th}$ day (one day before spinning) after transportation. Economic cocoon traits like cocoon weight (CW), shell weight (SW) and cocoon shell ratio (CSR) were recorded.

The experiment was carried out in a factorial design with three replications and a control, each, for transportation modes and means. Mean data of various parameters were statistically analyzed applying two way analysis of variance and difference among individual modes and means of transportation was realized by least significant difference (LSD) test. Moreover, interaction response among modes and means was ascertained too.

## Results and Discussion

Mean data on parameters of growth and cocoon characters of C-102 and 206-PO reared under cooperative house rearing conditions and transported by different transportation modes and means are presented hereunder. Variable overall effect of cooperative house rearing and transportation on test parameters was recorded. In both silkworm strains young age larvae reared under cooperative house conditions resulted in healthy worms and more cocoon and shell yield. Statistically this effect was significant in LBWG, CW, SW, CSR, but was non-significant in LBWG on $4^{th}$ day in C-102 and CSR of 206-PO. Similarly, transportation modes, means and their interaction displayed significant influence on growth and cocoon characters. Also individual comparison among modes and means showed significant variation. Strain wise effect of transportation modes and means is as follow:

## C-102

Effect of transportation modes was gradual i.e. it was non-significant on $4^{th}$ day of transportation but became highly significant on $15^{th}$ day. Maximum (3.267g$l^{-1}$) and minimum (3.108g$l^{-1}$) larval body weight gain was recorded on $15^{th}$ day in motorbike and control, respectively. Difference between bicycle and conventional methods of rearing; wagon and head load was non-significant. Likewise, transportation modes have highly significant impact on cocoon and shell weight while significant in respect of cocoon shell ratio. The heaviest cocoon (1.444g) and shell (0.302g) was in motorbike while cocoon shell ratio (21.39%) was in wagon. On the other hand these parameters have the least

values in control (1.297g, 0.268g, 19.83%). Cocoon weight did not differ significantly between wagon and head load. The difference in shell weight between bicycle and wagon; head load and control was non-significant (table 1).

Overall effect of transportation means was highly significant on larval growth and significant on cocoon shell. Though overall variable responses of transportation means were observed in case of cocoon weight and cocoon shell ratio but statistically impact was non-significant. On 15$^{th}$ day maximum (3.221gl$^{-1}$) and minimum (3.045gl$^{-1}$) LBWG was registered in wooden rearing tray and control, respectively. Shell weight was highest (0.289g) in wooden rearing tray and least (0.261g) in control. Moreover, the difference between wooden rearing tray and wax paper; wax paper and hard card box was non-significant (table 2).

Interaction between transportation modes and means was highly significant on 15$^{th}$ day after treatment, shell weight and cocoon shell ratio whereas, it was significant in case of cocoon weight. Maximum LBWG (3.266gl$^{-1}$), CW (1.525g), SW (0.319g) and CSR (22.32%) were obtained when worms were transported by motorbike in wooden rearing trays. These values were slightly higher than those reported under independent factors of modes and means. Combination of motorbike and wooden rearing tray afforded better growth of worms, cocoon and shell production than all other combinations. Adverse combinations were bicycle-WP, wagon-HCB and Head load-HCB for LBWG, CW and SW, respectively (table3).

Table 1. Effect of transportation modes on growth and cocoon characters of silkworm

| Transport Modes | LBWG on day | | Cocoon characters | | | LBWG on day | | Cocoon characters | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4$^{th}$ (g) | 15$^{th}$ (g) | CW (g) | SW (g) | CSR (%) | 4$^{th}$ (g) | 15$^{th}$ (g) | CW (g) | SW (g) | CSR (%) |
| | C-102 | | | | | 206-PO | | | | |
| Head Load | ns 0.677 | ** 3.179 b | ** 1.351 c | ** 0.273c | * 20.97ab | ** 0.667b | ** 3.045b | ** 1.209b | ** 0.255bc | ns 21.92 |
| Bicycle | 0.682 | 3.110 c | 1.404 b | 0.288b | 20.53b | 0.720a | 3.096b | 1.271a | 0.262b | 20.65 |
| Motorbike | 0.666 | 3.267 a | 1.444 a | 0.302a | 21.14a | 0.725a | 3.213a | 1.283a | 0.275a | 21.49 |
| Wagon | 0.694 | 3.151 b | 1.336 c | 0.286b | 21.39a | 0.715a | 3.163a | 1.281a | 0.262b | 21.13 |
| Control | 0.663 | 3.108c | 1.297 d | 0.268c | 19.83c | 0.666b | 2.971c | 1.148c | 0.251c | 20.43 |
| CD | 0.051 | 0.044 | 0.023 | 0.009 | 0.066 | 0.018 | 0.051 | 0.038 | 0.007 | 2.142 |

* significant at 95% level ** significant at 99% level, ns Non-significant

- Figures in a column sharing same alphabet(s) are non-significant among themselves at 95% level

## 206-PO

Effect of transportation modes and means on cooperative house reared larvae was highly significant on 4$^{th}$ day of treatment. Maximum (0.725gl$^{-1}$) and minimum (0.666gl$^{-1}$) LBWG was recorded in motorbike and control, respectively. The difference among motorbike, bicycle and wagon; between head load and control was non-significant. Almost same pattern in LBWG was observed on 15$^{th}$ day after transportation. Statistically the difference between motorbike and wagon; head load and bicycle was non-significant. Overall effect of transportation modes was highly significant on cocoon weight too. The heaviest cocoon (1.283g) was found in case of motorbike but that did not vary significantly with bicycle and wagon. Control gave the lightest cocoon (1.148g). Similarly the highest (0.275g) and lowest (0.251g) SW was noticed in motorbike and control, respectively. The variation among wagon, bicycle and head load; between control and head load was non-significant (table 1).

Influence of transportation means on larval growth escalated with the passage of time. It was overall significant on 4$^{th}$ day but became highly significant at maturity. On 4$^{th}$ and 15$^{th}$ day maximum larval body weight gain was in wooden rearing tray whereas minimum was in control. Overall response of cocoon weight towards transport means was non-significant however, it was in the order of highly significant and significant in SW and CSR. Both SW and CSR was maximum in wooden rearing tray and minimum in control. The difference between wooden rearing tray and wax paper was statistically non-significant both for SW and CSR (table 2).

Effect of transportation modes on means and vice versa was highly significant in all test parameters except CSR. Maximum LBWG (3.371gl$^{-1}$), CW (1.358g) and SW (0.287g) was obtained when worms were transported by motorbike in wooden rearing tray. These values were relatively more in case of combination of motorbike and wooden rearing tray than when these factors were analyzed independently. Head load in combination with wooden rearing tray retarded larval growth and decreased cocoon & shell weight (table 3).

Table 2: Effect of transportation means on growth and cocoon characters of silkworm

| Transport Means | LBWG on day | | Cocoon characters | | | LBWG on day | | Cocoon characters | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4th (g) | 15th (g) | CW (g) | SW (g) | CSR (%) | 4th (g) | 15th (g) | CW (g) | SW (g) | CSR (%) |
| | C-102 | | | | | 206-PO | | | | |
| Wooden Tray | * 0.696a | ** 3.221a | ns 1.367 | * 0.289a | ns 20.09 | * 0.717a | ** 3.182a | ns 1.245 | ** 0.268a | * 21.18 a |
| Hard card box | 0.661b | 3.179b | 1.356 | 0.279 b | 20.58 | 0.702 b | 3.053 b | 1.235 | 0.252b | 20.42 b |
| Wax paper | 0.671 b | 3.090c | 1.376 | 0.282 ab | 21.09 | 0.689 bc | 3.057b | 1.235 | 0.263a | 21.76 a |
| Control | 0.637cb | 3.045d | 1.299 | 0.261 c | 20.03 | 0.670 c | 2.805 c | 1.169 | 0.240c | 20.31b |
| CD | 0.016 | 0.034 | 0.155 | 0.007 | 1.608 | 0.014 | 0.04 | 0.045 | 0.006 | 0.677 |

* significant at 95% level, ** significant at 99% level, ns Non-significant

- Figures in a column sharing same alphabet(s) are non-significant among themselves at 95% level.

Present findings revealed that young age worms reared under cooperative house rearing conditions *viz*., 27±1℃ and 85±5% relative humidity have positive impact on growth of worms and ultimately on cocoon production. These results are in corroboration with Raghuraman and Sekharappa (1989). They found that management of silkworm during young age had direct influence on subsequent development and cocoon production. Young age worms of C-102 reared under cooperative house conditions and transported by motorbike gave 5.12%, 11.334% and 12.69% more LBWG, CW and SW, respectively as compared with conventional methods of rearing. In 206-PO likewise, gained 8.15%, 11.76% and 9.56% more LBWG, CW and SW, respectively. These results are in conformation with Gupta *et al.* (1986) and Jolly (1986). Gupta *et al*. (1986) reported 35 percent more cocoons in case of supply of 2nd instar larvae produced by chawki rearing centre than by traditional methods of rearing. And Jolly (1986) recorded increase of 6-7kg of cocoons/100dfls for larvae brushed in chawki over direct brushing at rears' place. Discrepancy in results might be due to different silkworm strains and day timing of transportation

Table 3: Effect of transportation modes and means interaction on silkworm growth and cocoon characters

| Transport Modes | Trans-port Means | FLBW (g) | CW (g) | SW (g) | CSR (%) | LBW (g) | CW (g) | SW (g) | CSR (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | C-102 | | | | 206-PO | | | |
| Head load | WRT | ** 3.231ab | * 1.323g | ** 0.270ef | ** 20.43bcde | ** 2.74g | ** 1.042f | ** 0.227f | Ns 21.80 |
| | HCB | 3.062d | 1.35efg | 0.264f | 19.53e | 3.092d | 1.210de | 0.253e | 20.99 |
| | WP | 3.032d | 1.379ef | 0.269ef | 19.53e | 3.302ab | 1.191de | 0.272bc | 22.91 |
| Bicycle | WRT | 3.246a | 1.421cd | 0.284de | 19.95cde | 3.121d | 1.327ab | 0.275abc | 20.71 |
| | HCB | 3.142c | 1.359efg | 0.285cd | 20.96bc | 3.287ab | 1.326ab | 0.268cd | 20.18 |
| | WP | 2.942e | 1.433bc | 0.297bcd | 20.70bcd | 2.879f | 1.161e | 0.244e | 21.04 |
| Motorbike | WRT | 3.266a | 1.525a | 0.319a | 22.32a | 3.371a | 1.358a | 0.287a | 22.95 |
| | HCB | 3.155cd | 1.345fg | 0.300bc | 20.93bc | 3.113d | 1.238cd | 0.255de | 20.59 |
| | WP | 3.261a | 1.462b | 0.288cd | 19.67de | 3.157cd | 1.254cd | 0.285ab | 20.96 |
| Wagon | WRT | 3.029d | 1.387de | 0.285cd | 20.54bcd | 3.221bc | 1.325ab | 0.267cd | 20.17 |
| | HCB | 3.162cd | 1.248h | 0.266f | 21.35ab | 2.970e | 1.232cd | 0.244e | 19.80 |
| | WP | 3.213abc | 1.374ef | 0.307ab | 22.29a | 3.299ab | 1.284bc | 0.273bc | 21.30 |
| CD | | 0.075 | 0.039 | 0.015 | 1.137 | 0.088 | 0.066 | 0.013 | 2.142 |

* significant at 95% level, ** significant at 99% level, ns. non-significant

- Figures in a column sharing same alphabet(s) are non-significant among themselves at 95% level

Performance of young age worms reared in cooperative house however, is subjected to many factors principally to transportation modes, means, timings, etc. Muniraju *et al*. (2003). Our findings too reveal a diversified impact of transportation modes and means on growth and cocoon traits. Moreover, effect of transportation modes and means varies with silkworm strains. Transportation by head load and wax paper of transportation have negative influence on all under study parameters. Young age larvae of C-102 and 206-PO transported by motorbike gave 5.05% (LBWG), 6.88% (CW), 10.62% (SW) and 5.52% (LBWG), 6.12% (CW), 7.84% (SW) more than that of head load. Larvae transported in wax paper reduced LBWG by 4.24% (C-102) and 4.09% (206-PO) against the wooden rearing tray. Reports of Muniraju *et al.* (2003) also substantiate these outcomes. They also found lower yield in head load and better cocoon and shell weight in wooden trays and Hard card box. Negative impact of head load and wax paper may be due to more physical disturbance in former and adverse micro-climatic conditions in case of latter.

## Conclusion

Based on the present results it is concluded that cooperative house rearing of young age worms give better growth performance and subsequently more cocoon production. Among transportation modes motorbike is more beneficial than head load. Wooden rearing tray as transportation mean out paces hard card box and wax paper. It is therefore, recommended that young age larvae should be reared under cooperative house rearing conditions and be transported by motor bike-wooden rearing tray combination for healthy growth, more cocoon yield and economic returns.

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