

6. SUMMARY

An investigation was carried out on the mulberry silkworm *Bombyx mori* L. (Lepidoptera : Bombycidae) in its two breeds, multivoltine Nistari, bivoltine KPGB and in a bivoltine hybrid (KPGB x P₅) during both dry and wet part of summer in the subtropical plains of West Bengal, India. The effect of starvation on any single day of the fifth instar larvae and such starvation accompanied with the juvenile hormone analogue, methoprene (0.3125 µg/larvae) was assessed on the reproductive and economic (cocoon) characters. The object was to identify the day/days of fifth larval life when starvation will cause the least impairment of those characters. Furthermore, the JHa was used to explore the possibility of recovering the impairment due to starvation.

An additional experiment was conducted for an understanding of the effect of the imidazole derivatives KK-42, KK-110 and KK-22 for raising the trimoulter male moths of the bivoltine hybrid (KPGB x P₅) so that polyvoltine X bivoltine hybrids eggs can be produced and reared commercially during the adverse wet part of summer in the subtropical plains of West Bengal.

Effect of Starvation on Any Single Day and Starvation accompanied with the JHa Administration

Consumption and assimilation of food : Both consumption and assimilation of food by the larvae of all the three breeds were higher during wet part than during the dry part of summer. The result obtained after treatment with methoprene was also of identical nature.

The effects of starvation on consumption were least on the days 3 and 5 in Nistari, days 2, 6 and 7 in KPGB and days 2 and 7 in the hybrid KPGB x P₅ during the dry part of summer. Such least affected days during wet part of summer were day 5 in Nistari and KPGB x P₅ and day 7 in KPGB. The application of methoprene through increased the food consumption, the JHa

could not recover the larvae from the impairment of loss of consumption in KPGB and KPGB x P₁, which was rescued in case of Nistari.

◦ The assimilation was least affected due to starvation on days 2 and 3 in Nistari, days 6 and 7 in KPGB and days 7 and 8 in the hybrid during dry part of summer. During the wet part of summer the least affected days were 2 in Nistari, 7 in KPGB and 2 and 3 in hybrid. Application of methoprene could not recover the loss in assimilation due to starvation except in the larvae of the hybrid starved on day 8 and only during wet part of summer. In these larvae there was some recovery of the loss in assimilation.

Efficiency of conversion of digested food : The values of ECD on larval body was least affected due to starvation on days 3 and 4 in Nistari, 5 in KPGB and 2 and 3 in the hybrid during dry part of summer. During wet part of summer such days were 6 in Nistari, 7 in KPGB and 4 in this hybrid. The JHa reduced the ECD values irrespective of the seasons.

The ECD for male cocoon shell was least affected by starvation on the days 2 and 4 in Nistari, 5 in KPGB and 5 in the hybrid during dry part of summer. During wet part of summer the least affected days were 6, 2 and 2 in case of Nistari, KPGB and the hybrid respectively. The ECD values for the female cocoon shells were lowered least because of starvation on the days 2 and 4 in Nistari, 5 in KPGB and the hybrid during dry part of summer. The least affected days during wet part of summer were 6 in Nistari, 2 and 8 in KPGB and 5 in the hybrid. Irrespective of seasons and sexes the JHa application reduced ECD value in all the starvation days.

The ECD for pupal biomass has been least affected by starvation during dry part of summer on the days 4 in Nistari and 5 in KPGB and the hybrid. During wet part of summer such days were 3 in Nistari, 2 and 7 in KPGB and 5 in the hybrid. The JHa reduced the ECD values for pupal biomass.

Economic Characters : The starvation-induced impairment of the ERR values were least on the days 3 in Nistari, 7 in KPGB and 8 in the hybrid during dry part of summer. During wet part of summer such days were 3 in Nistari, 7 in KPGB and 5 in the hybrid. Methoprene had no capacity to improve the impairment.

The least affected days for the final larval weight due to starvation were 3 in Nistari, 6 in KPGB and 2 in the hybrid during dry part of summer. Similarly the least impairment on the final larval weight occurred on the starvation days 3 in Nistari, 8 in KPGB and 4 in the hybrid during wet part of summer. Methoprene though improved the larval weight, it could not recover the impairment totally.

During dry part of summer the weight of cocoon in both the sexes were least impaired by starvation on day 2 in Nistari and 6 in KPGB. The least impaired days for the hybrid were 2 in male and 7 in female. For the wet part of summer such least affected values were obtained on days 3 in Nistari, 6, 7 and 8 in KPGB and 2 in bivoltine hybrid. Methoprene was able to recover the impairment in all the days except day 4 in Nistari and on days 4,5,6,7,8 in males of KPGB x P₅ during wet part of summer. In rest of the days the action was below the control value. During dry part of summer rescue from impairment was better for Nistari in both the sexes, but in KPGB and also in KPGB x P₅ due to cumulative action of starvation and low digestibility, caused by the action of JHa, the impairment towards the cocoon characters was not recovered.

Reproductive Characters : For practical reason the study was restricted to the females only. There is a good correlation between the pupal biomass and reproductive performance of the females. The characters considered in this regard were live pupal weight, total ovariole length, number of eggs in ovariole and fecundity. Least impairment on the reproductive characters due to starvation was obtained on day 2 in Nistari, 7 in KPGB and 2 in the hybrid during dry part of summer. During wet part of summer results obtained were same for Nistari and KPGB, but in KPGB x P₅ least effect was on day 5. The action of

methoprene increased the fecundity in all the breeds. The values were higher than JHa free control larvae in all the days except 4 and 5 during dry part of summer and except for days 4, 5 and 6 during wet part of summer in Nistari only. The impairment was not rescued in KPGB and the hybrid during any of the seasons.

Utilization of leaf nitrogen : The starved larvae efficiently utilized high amount of leaf nitrogen during the wet part of summer as compared to that with the dry part due to high water level in the leaves. Better nitrogen digestion has been observed for starvation days 4 and 5 in Nistari, 6 and 7 in KPGB and in all the days except 5 in hybrid during the dry part of summer. During wet part of summer starvation on the days 2 and 4 in Nistari, 6 and 7 in KPGB and 4 in KPGB x P₅ exhibited better result. Treatment with methoprene increased nitrogen accumulation in larval body but digestibility got reduced. Higher flow of nitrogen towards both male and female cocoon shell was observed for starvation days 3 and 4 in Nistari, 6 in KPGB and 2 in KPGB x P₅ during dry part of summer. During the wet part better result was observed for the days 3 and 4 in Nistari, 7 and 8 in KPGB and 3 in KPGB x P₅ for both males and females.

From the results it can be inferred that any single day food deprivation directly affects the economic and the reproductive characters. However, if needed, be during dry part of summer starvation may be imposed on day 3 in Nistari, 6 in KPGB and day 2 in the hybrid. During wet part of summer the safe days for starvation are day 3 in Nistari, 6,7 and 8 in KPGB and 2 in the hybrid. Simultaneous application of methoprene after 48 hrs in fifth instar would help in increasing fecundity in all the breeds in both the seasons as compared to that with JHa free starved batches.

Effect of the Imidazole Derivatives for producing Trimoulter males of KPGB x P₅

The imidazoles, KK-42, KK-110 and KK-22 were applied topically on the

fourth instar larvae of the hybrid KPGB x P₅ of *B.mori* during wet part of summer for the production of trimoulters.

Determination of Effective Dose : A dose of 3 µg/larva of KK-42 induced 92% precocious cocoon formation and 94.56% pupation, 1 µg/larva induced only 70% pupation whereas, a higher dose of above 4 µg/larva caused larval death. Treatment with 10 µg/larva of KK-110 induced 93% pupation, and a dose of 5 µg/larva resulted in only 30% precocious pupation, a higher dose of 15 µg/larva utterly reduced pupation. KK-22 at a dose of 5 µg/larva caused 26% precocious metamorphosis and 84.69% pupation, 10 µg/larva caused 75% precocious metamorphosis and 80.69% pupation and at 20 µg/larva there occurred 86% precocious metamorphosis and 90.1% pupation.

Thus, a dose of 3µg of KK-42, 10 µg of KK-110 and 20 µg of KK-22 per larva were considered the effective doses for the induction of trimoulter during wet part of summer in West Bengal.

Performance of the Larvae Treated with the Effective Doses of the Imidazoles

Nutritional efficiencies : The consumption of mulberry leaves, assimilation, absolute consumption, absolute gain in larval weight and absolute growth rate were much higher in the larvae treated with the effective doses of the imidazoles than in the control fourth instar larvae. But the values were much lower than those of control fifth instar larvae or the combined values of fourth and fifth instar larvae. On the whole, the values of the trimoulter-destined larvae treated with the effective doses of all the three imidazoles were close to each other. The ECD% to pupal biomass in both the sexes was increased to higher levels by all the three imidazoles with concomitant decrease in values of ECD% for cocoon shell. The trimoulter larvae consumed 50% of the total nitrogen consumed by the control tetramoulters. But the digestibility was higher than in the control larvae with correspondingly low level of excretion. The efficiency of conversion

of digested nitrogen to larval body was 100% , 94.28% and 96.55% in cases of KK-42, KK-110 and KK-22 treatments respectively as against the 92.3% in control larvae. The result reveals a higher efficiency of nitrogen utilization by the trimoulter-destined larvae. The sharing of larval body nitrogen for cocoon shells was lower in the imidazole-treated individuals than in the control. Concomitantly the pupal share of nitrogen was higher in the trimoulters than in the control. The result justifies that induced trimoulters of *B.mori* are more programmed towards the perpetuation of race than to contribute to the protective shell.

Rearing performance : The effective rate of rearing (ERR%) was improved considerably. The values were 85% in KK-42, 78% in KK-110 and 81% in KK-22 as against only 62% in case of control tetramoulters. Compared with the control fourth instar larvae the larval duration of treated trimoulter-destined larvae was extended from 3.0 to 3.7 days. Relative to the control values the average weights of male and female cocoons were 54 and 64% in KK-42, 46.7 and 60.4% in KK-110 and 63.25 and 71.4% in KK-22 respectively. The corresponding shell weights were 34.6 and 37% in KK-42, 31.9 and 35.4% in KK-110 and 34.3 and 37.2% in KK-22. The silk filament length were less than 50% of the control value in cases of KK-42 and KK-110 administration whereas it was a little above 50% in case of KK-22 treatment. The denier (size of silk filament) also decreased in the trimoulters resulted from the imidazoles, the average values being 1.57, 1.51 and 1.90 as against the control value of 2.01.

Reproductive Performance : The female pupae contribute largely to egg production. Therefore, the female pupal weights obtained from the trimoulters were not so much reduced. With comparison to the control values the weights were 65% in KK-42 and KK-110 and 70% in case of KK-22.

The moth emergence time i.e., pupal duration were reduced in the trimoulters by one day than in the control tetramoulters.

The fecundity was reduced than in the control. In comparison to the control values the fecundity was 69.37% in case of KK-42, 67.19% in KK-110 and

61.98 in case of KK-22. Interestingly the egg vigour and the weights of newly hatched larvae did not differ between the tri - and tetramoulters.

Rearing Performance in the Next Generation Obtained from the Cross Between Polyvoltine Nistari Females and Bivoltine Trimoulter Males

The fecundity of the resultant moths was at par with the values obtained from the hybrid of Nistari females and tetramoulter bivoltine males. Even there was no adverse effect on spermiogenesis. This was evident from the hatching percentage which was at par with the control value. This implies that the reproductive potency of the trimoulter males is not impaired by the imidazoles.

The egg vigour and newly hatched larval vigours were not reduced as evident from the weights of 100 eggs and 100 newly hatched larvae.

Similarly the cocoon weights, cocoon shell weights, SR% and filament length, were at par with the results of tetramoulter control. Thus, the rearing performance and economic (cocoon) characters are maintained in the next generation.

Rearing Performance of the Eggs Obtained from the trimoulter bivoltine females

The rearing performance in the next generation in respect of economic and reproductive characters was at par with the control results of both favourable and unfavourable seasons. The trimoulters retained their tetramoulter quality. Thus, the trimoulter eggs may be of commercial value in the sub-tropical humid plains such as in West Bengal.

The overall result suggests that the imidazoles in effective doses are very useful for bivoltine silkworm rearing during wet part of summer. Furthermore, these can be used for the production of polyvoltine X bivoltine hybrid eggs for rearing of commercial crop during this adverse season.