PERFORMANCE OF THE SELECTED RACES OF MULBERRY SILKWORM [*Bombyx mori L.*] IN THE EASTERN DRY ZONE OF KARNATAKA

G. M. VISWANATHA, B. Sc., (Agri.)

DEPARTMENT OF SERICULTURE
UNIVERSITY OF AGRICULTURAL SCIENCES
BANGALORE-560 065

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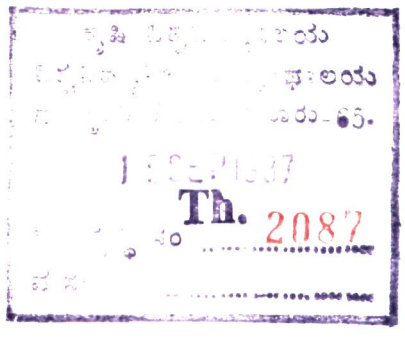

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G. M. VISWANATHA, B. Sc., (Agri.)

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University of Agricultural Sciences, Bangalore
in partial fulfilment of the requirements
for the award of the degree of

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in

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BANGALORE

JULY 1987

Affectionately Dedicated to

My Beloved Parents.

DEPARTMENT OF SERICULTURE

UNIVERSITY OF AGRICULTURAL SCIENCES
BANGALORE

CERTIFICATE

This is to certify that the thesis entitled

"PERFORMANCE OF THE SELECTED RACES OF MULBERRY SILKWORM (*Bombyx mori* L.) IN THE EASTERN DRY ZONE OF KARNATAKA" submitted by Mr.VISWANATHA, G.M. for the degree of MASTER OF SCIENCE (AGRICULTURE) in SERICULTURE to the University of Agricultural Sciences, Bangalore, is a record of bona fide research work done by him during the period of his study in this University under my guidance and supervision and the thesis has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles.

(C. SIDDAPPAJI)
Associate Professor of Entomology
Department of Sericulture

Bangalore
July, 1987

APPROVED BY:

Chairman : (C. SIDDAPPAJI)

Members: 1. (B.L.VISWESWARA GOWDA)

2. (B.K.NAGESHCHANDRA)

3. (C.A. VIRAKTAMATH)

4. (R.V.KRISHNAMURTHY)

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INTRODUCTION

I. INTRODUCTION

Sericulture is labour intensive, providing gainful occupation to the un-employed and under-employed in rural and semi-urban areas and an export oriented agro-based industry. In practice of sericulture particularly in relation to silk cocoon production certain amount of risk is invariably experienced as it involves both plant and animal husbandry.

Karnataka is the largest silk producing state in India. Although Karnataka is gifted with a sericulture climate where environments favour the growth of mulberry as well as silkworm Bombyx mori Linnaeus and the resources are fairly available. The cocoon crop is raised throughout the year in some part or the other with a few races of silkworm. The cocoon crop yields have been stagnant and unstable, despite the progressively increasing area under irrigation and increased consumption of chemical fertilizers coupled with the use of modern high yielding varieties of mulberry and bivoltine races which are replacing the local multivoltine race. The indigenous races have been in harmony with the ecosystem, in that the sericulturists

are able to harvest cocoon crops even under most severe stress situations. Introduction of the new bivoltine race even under such drought, warm to very warm dry situations, have not resulted in any stability in the cocoon yield. In order to stabilise cocoon yield which assures good returns, there is always a need to understand suitability of the silkworm race to the existing agro-climatic conditions in a given situation.

Karnataka enjoys a variety of climate and classified to have ten agro-climatic zones following under six regions (Figure 1) based on topography, rainfall pattern, soil characteristics, crops and cropping pattern etc. (Anonymous 1984). Sericulturally Karnataka is categorised into two areas viz., traditional and non-traditional. In the former, largest area under sericulture is in Mysore district, followed by Kolar, Bangalore and parts of Tumkur districts. In Mysore and parts of Tumkur districts sericulture is practiced in a highly traditional manner using local cultivar of mulberry and multivoltine silkworm race and their crosses are reared, while in Kolar and Bangalore districts the cocoon crops are raised in an intensive manner. Lot of disparities in cocoon

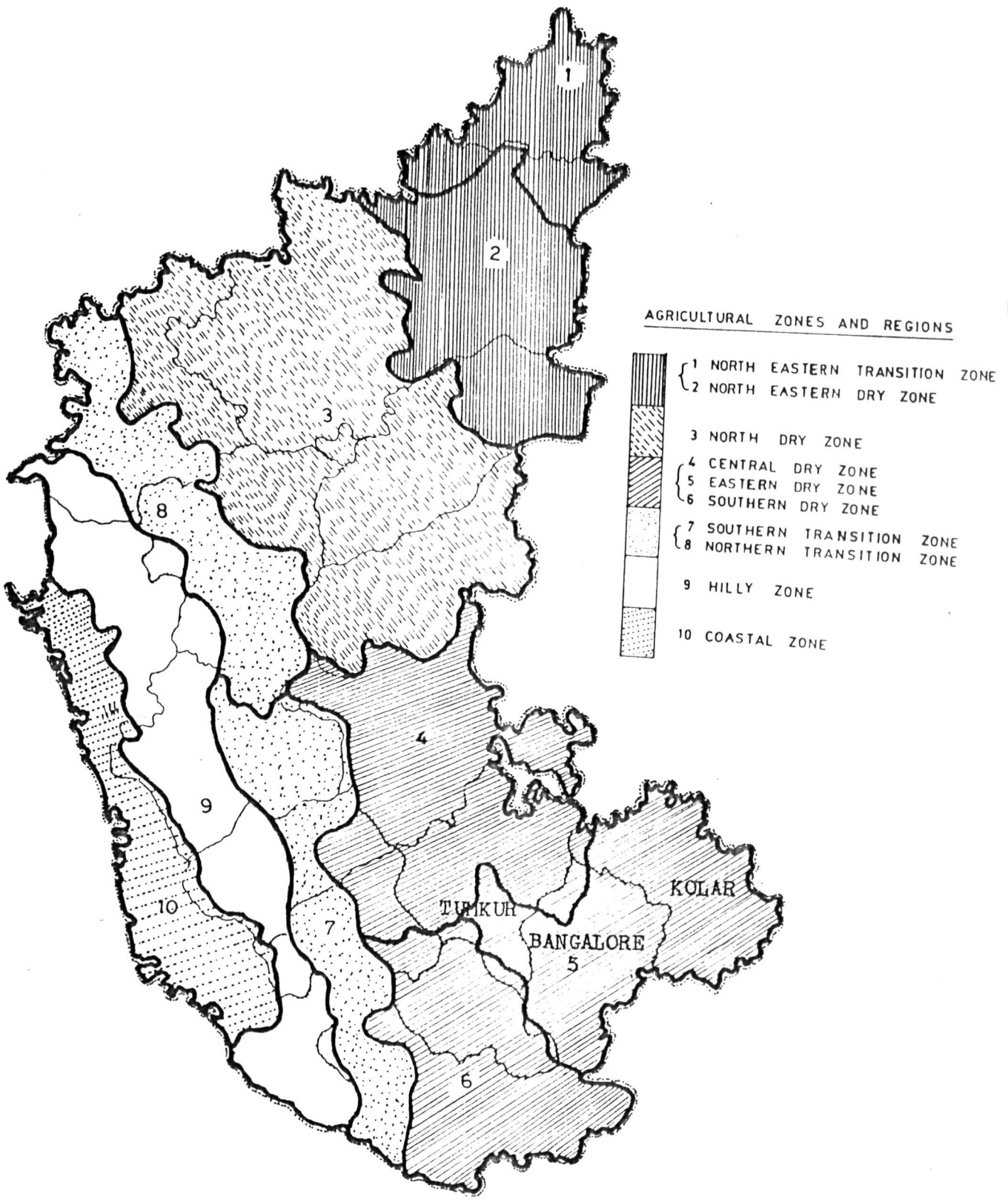

FIG. 1: MAP SHOWING AGRICULTURAL ZONES AND REGIONS OF KARNATAKA.

yield exist in the latter districts between and among silkworm races.

The silkworm races are categorised into univoltine, bivoltine and multivoltine based on physiological and ecological factors. The cocoon yield potentialities of different silkworm races are influenced by certain ecological factors such as season of rearing, type of rearing, rearing sites, leaf quality, resistance to diseases and pests and thus to poor environment etc.

Taking the yield (being the cocoon yield), under certain specially created conditions with strictly specified inputs and management, four new bivoltines viz., NB_7, NB_{18}, NB_4D_2 and KA have been introduced as a measure of stepping up industrial cocoon production and to achieve the international quality standards over a widely varying agro-climatic conditions of the state. In the case of silk production, though the technology of rearing new bivoltine and multivoltine cross breeds corresponds quite closely to modern sericultural technology, not much success has yet been achieved in introducing the pure bivoltines on the Karnataka scene in a big way.

In a recent survey in Karnataka on "cocoon production and crop loss" the pure bivoltine race viz., NB_4D_2 and the cross breed (multivoltine X bivoltine) viz., PM X NB_4D_2 are popular with the sericulturists during rainy, post-rainy and throughout including summer months, respectively in the traditional sericulture area. While in Mysore district the local multivoltine and their crosses are reared by most, despite the thrust strategy for bivoltine silk production, (Siddappaji et al., 1985, 1987).

Any new race of silkworm can be successful in a few places, it may not be suitable for other environments. A variety irrespective of the environment giving significantly higher yield over the local or regional average yield under farmers condition in all the crop seasons may be defined as having high yielding potentialities and wider adaptability. The new race or strain of silkworm should be as good as traditional once in local adaptability and the related economic characteristics but not inferior in any characteristic.

It is in this context the present study was undertaken to evaluate the performance of the more popular races of mulberry silkworm during different crop rearings as suited to Eastern Dry Zone with University of Agricultural Sciences, Bangalore as centre with the following objectives:

1. to work out the effective rate of rearing (ERR) of the mulberry silkworm races,
2. to study the seasonal influence on cocoon productivity,
3. to study the yield potentialities and the related economic parameters of silk cocoons.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The literature pertaining to present investigation and related aspects on the performance of mulberry silkworm (Bombyx mori L.) races is reviewed and presented below:

Some advantages of silkworm rearing to be considered in rearing the improved breeds of silkworm are a) Increasing the production of cocoons per unit weight of mulberry, b) Increasing the shell weight and weight of reelable silk, c) Decreasing the formation of double cocoons, d) Increasing the length and size of filament, e) Increasing the evenness of filament, f) Increasing the neatness of filament and g) Increasing the resistance to poor environment, (Anonymous, 1956, 1975).

The Eastern Dry Zone comprises of Bangalore, Kolar and parts of Tumkur districts where the annual rainfall ranges from 679 to 889 mm. This zone consists of Devanahalli, Doddaballapur, Nagadi, Bangalore North, Bangalore South, Kanakapur, Ramanagaram, Channapatna, Hoskote and Nelamangala taluks of Bangalore districts, Malur, Bangarpet, Mulabagilu, Srinivaspur, Chintamani,

Bagepalli, Chikkaballapur, Gowribidanur, Gudibanda, Kolar and Shidlagatta taluks of Kolar district and Gubbi and Tumkur taluks of Tumkur district (Anonymous, 1984).

2.1 Effective rate of rearing (ERR) of the mulberry silkworm races

In a study with local multivoltine race viz., Pure Mysore the number of normal cocoons (ERR) per 10,000 larvae brushed for different rearings in December 1966-January 1967, February-March 1967, May-June 1967, July-August 1967, August-September 1967, November-December 1967 and January-February 1968, was 8,041 (80.41%), 7,946 (79.46%), 8,075 (80.75%), 6,985 (69.85%), 2,113 (21.13%), 5,558 (55.58%) and 4,928 (49.28%), respectively (Anonymous, 1968).

Narasimhanna and Sudhakaran (1973) assessed the cocoon crop during different rearings in March 1972, April-May 1972, September-October 1972, November-December 1972, and January-February 1973 and found that the effective rate of rearing was 93.3, 92.0, 93.0, 95.1 and 93.3 per cent in PM X HS_6 and 94.0, 96.0 95.7, 95.0 and 97.0 per cent for PM X C.nichi during the above mentioned rearings, respectively.

The breeder batches of bivoltine races viz., KA resulted in the best yield during June-July 1974 with 9,676 (96.76%) cocoons, followed by January-February 1975 rearing, with an yield of 8,865 (88.65%) cocoons per 10,000 larvae brushed. The NN_6D gave best results in August-September 1974 with 9,009 (90.09%) cocoons followed by April-May 1974 rearing with 8,611 (86.11%) cocoons per 10,000 larvae brushed (Narasimhanna et al., 1975).

The effective rate of rearing was 81.5 per cent in a bivoltine hybrid viz., KA X NB_7 and 86.9 per cent in another hybrid KA X NB_4D_2 further they observed an improvement in survival capacity of the cross breed by more than 21 per cent compared to pure bivoltine races (Benchamin and Krishnaswamy, 1981).

Kapila et al. (1983) observed the summer crop performance with the multivoltine X bivoltine cross viz., PM X NB_{18} at Regional Sericultural Research Station, Sujanpur and found an effective rate of

rearing of 95.16 and 91.52 per cent during July 1981 and June 1982, respectively. In late summer the cross breed viz. PM X KA showed 82.5 per cent effective rate of rearing.

2.2 Seasonal influence on cocoon productivity

The yield potentiality of PM X C.nichi was 5.84, 7.92, 6.30, 8.57, 4.76 and 8.26 Kg cocoons per 10,000 larvae brushed during March-April 1969, May-June 1969, June-July 1969, August-September 1969, October-November 1969 and December 1969-January 1970, respectively, (Anonymous, 1970).

Tikoo et al. (1971) reported that the yield by weight for 10,000 larvae brushed among multivoltine X bivoltine hybrids reared during different seasons at different centres showed no significant differences, except in May-June 1969 and February 1970. The hybrid race viz., PM X J_{112} gave maximum yield of 10.407 Kg as against PM X (C_{108} X J_{112}) with 7.857 Kg cocoons, respectively.

Sidhu (1975) studied the yield performance of the cross breeds viz., PM X C.nichi, PM X HH_6, PM X Kolar Gold and PM X N_{54} and recorded cocoon yield of 19.653, 20.366, 20.440 and 24.117 kg per 100 layings respectively during March-April 1974, 22.162, 31.806, 32.480 and 30.673 kg per 100 layings, respectively during May-June 1974, 27.399, 29.110, 25.895 and 29.273 kg per 100 layings, respectively during July-August 1974, and 23.925, 28.022, 27.064 and 31.921 kg per 100 layings, respectively during October-November 1974.

Krishnaswami (1979) reported that almost 50 per cent of the mulberry silk cocoon production comes from spring season which was most favourable for silkworm rearing yielding upto 40 kg cocoons per box (50) of eggs. Summer season was fairly warm contributed only 10 per cent of cocoon production, being unfavourable for rearing. The autumn season once again was favourable yielding upto 40 per cent of cocoons.

Saheb (1981) studied the behaviour (cocoon yield) of bivoltines and found that the pure bivoltine strains viz. KA, NB_7, NB_{18} and NB_4D_2 as better during early summer with the highest cocoon yield of

35.21, 30.55, 31.54 and 34.13 Kg per 100 layings than in monsoon season which recorded the lowest cocoon yield of 9.37, 7.01, 7.12 and 12.62 Kg per 100 layings, respectively. Sharif and Rajan (1981) observed a maximum yield of 52 Kg cocoon per 100 layings for bivoltine hybrid viz., NB_{18} X NB_7 during December-January season.

Chandrashekar (1981) obtained a maximum average cocoon yield of 37.900 Kg during February 1981 and minimum average cocoon yield of 12.000 Kg per 100 layings during June 1980 in the case of multivoltine X bivoltine hybrids viz., PM X NB_4D_2 and PM X KA.

Parthasarathi and Ananthanarayan (1981) recorded the maximum average yield of 34.80 Kg per 100 layings during January 1981 and minimum average yield of 17.05 Kg cocoons per 100 layings during June 1980 with bivoltine hybrids.

Mariswamy et al. (1982) obtained the maximum yield of 30.990 and 38.030 Kg and the minimum of 8.350 and 11.060 Kg cocoons per 100 layings with NB_{18} and NB_4D_2 races during February-March 1982 and May 1982 rearings, respectively.

The approved bivoltine races viz., NB_7, NB_{18}, NB_4D_2 and KA recorded the maximum cocoon yields of 78.14 Kg in August-September 1982, 81.50 Kg per 100 layings in August-September 82, 50.21 Kg in October-November 1982 and 51.40 Kg in October-November 1982, respectively. The minimum yield of 26.93 and 26.930 Kg per 100 layings during May 1982 was for NB_7 and NB_{18}, respectively (Anonymous, 1983a).

In Andhra Pradesh, according to a report (Anonymous, 1983c) the performance of bivoltine hybrids viz., NB_7 X NB_{18} and KA X NB_4D_2 during November-December 1982 and January-February 1983 rearings, the maximum yield was 60.00 and 53.30 Kg cocoon per 100 layings, respectively, compared to other bivoltine hybrids. The performance of bivoltine hybrids was better during winter months compared to summer and rainy months.

The yield performance of bivoltines for three rearings biz., November-February, May-June and July-August, was 46.0, 42.0 and 49.0 Kg for NB_7, 48.3, 41.2 and 48.4 Kg for NB_{18}, 49.0, 42.5 and 46.1 Kg for NB_4D_2 and 48.0, 40.9 and 46.6 Kg for KA per 100 layings, respectively (Narasimhanna *et al.*, 1983).

Tayade (1983) studied the cocoon yield of different silkworm races and found it was as high as 29.70 Kg per 100 layings in Wai-4 among multivoltines during August-September 1979 36.5 Kg per 100 layings in KA among bivoltines during July-August 1979 and 45.5 Kg per 100 layings in PM X KA during July-August 1979 and 45.5 Kg per 100 layings in PM X KA among cross breeds during October-November 1979 rearings, respectively.

A study on "Field performance and variation in cocoon parameters of commercial hybrids of silkworm Bombyx mori L. in Karnataka" conducted by Ravi (1986) indicated that the average cocoon yield for PM X NB_4D_2 was 32.39, 18.52 and 27.53 Kg and for PM X NB_{18} it was 31.25, 18.58 and 21.86 Kg during winter (December to February), summer (March to May) and rainy (June to August) seasons, respectively. The cocoon yield was high in the case of PM X NB_4D_2 in two seasons except in summer.

Based on response and cocoon yield levels, Siddappaji et al. (1987) reported that the pure bivoltine viz., NB_4D_2 and the cross breed PM X NB_4D_2 were the ruling races in Karnataka. According to

them the latter was more popular and reared by most during rainy, post-rainy and summer months due to their inherent capabilities, wider adaptability and high productivity. They also suggested that the awareness with the industrial cocoon producers to raise pure bivoltines during rainy and post-rainy months, and cross breeds during summer months respectively would go a long way in stepping up cocoon production.

2.3 Yield potentialities and related economic parameters

Cocoon yield potentialities

It is reported that the cocoon yield potentialities of PM X C.nichi, PM X HS_6, PM X Kolar Gold and PM X J_{112} was 23.13, 24.55, 24.65 and 26.70 kg per 100 layings, respectively (Anonymous, 1971).

Benchamin et al. (1976) reported that the cocoon yield of pure bivoltines viz., NB_4D_2 was better than that of the KA and NN_6D, with 24,015, 19,970 and 20,625 cocoons per 100 layings respectively.

Ganesh et al. (1976a) reported that the overall performance of bivoltine hybrids was satisfactory in

Kolar and Bangalore regions with the average cocoon yield of 34.0 Kg for KA and NN_6D hybrids, 37.0 Kg for new bivoltine hybrids, 39.0 Kg for 'Nandi' hybrid 32.0 Kg for pure bivoltines, and 24.0 Kg for multivoltine hybrids, per 100 layings. Ganesh et al. (1976b) stated that the rearing of bivoltine hybrids was more economical than multivoltine hybrids. The new bivoltine hybrids registered a better yield (37.0 Kg) compared to hybrids of KA and NN_6D (34.0 Kg). The other race KA X NB_5C tried recorded a maximum cocoon yield of 51.0 Kg per 100 layings.

Narasimhanna et al. (1976) reported the performance of the bivoltine hybrid viz., NB_4D_2 X KA yielded 42.0 Kg per 100 layings on an average as against 32.0 Kg per 100 layings for KA X NN_6D.

Jolly and Benchamin (1981) reported that the cocoon yield of reciprocal crosses of multivoltine X bivoltine combinations viz., PM X NB_{18}, NB_{15} X PM, PM X NB_7, NB_7 X PM and PM X (NB_{18} X NB_7), (NB_{18} X NB_7) X PM with the cocoon yields of 13.260, 10.351, 11.510, 11.418, 13.948 and 11.288 Kg per 10,000 larvae, respectively.

Chandrashekariah et al. (1981) stated that the comparative performance of bivoltine was markedly superior compared to multivoltine hybrids in Kolar and Bangalore districts of traditional area. While hybrid of PM X NB_4D_2 yielded 50.1 Kg/100 layings. Among bivoltine hybrids and bivoltine races viz., NB_{18} X KA and NB_4D_2 yielded 45.3 and 43.6 Kg cocoons per 100 layings, respectively.

Related economic parameters of silk cocoons

Krishnaswami et al. (1971) stated that the relative performance of the exotic races like C.nichi HS_6, J_{112}, J_{112}, C_{108} and KA was better compared to pure Mysore with regard to all the important qualitative characters. The latter recorded the highest larval duration of 30:17 days; hours and least weight of cocoon, shell and shell ratio of 0.983 g, 0.141 g and 10.27 per cent, respectively than that of Pure exotic races tried.

Viswanath and Nagaraju (1975) observed that the variation in single cocoon weight, shell weight and shell ratio varied very much and ranged from

1.250 to 1.430 g, 0.200 to 0.250 g and 15 to 18 per cent for KA X NN_6D, respectively.

Benchamin et al. (1976) observed that the number to weight of cocoons as 748, 763 and 756 per kg weight in the case of NB_4D_2, KA and NN_6D, respectively.

Saheb (1981) observed the maximum number of cocoons for NB_4D_2, KA, NB_{18} and NB_7 was 845, 804, 789 in May 80 and 789 in March 80 cocoons per kg weight, respectively. While a minimum of 664 in January 81, 681, 654 in November 80 and 657 cocoons per kg in October 80 for the above races respectively.

Kamath and Sindagi (1981) reported that the number of cocoons per kg was maximum (734) during June 1980 and minimum (628) during January-February 1981 in the case of bivoltine hybrids.

Kamath et al. (1981) found that the number of cocoons per kg was 695, 620, 600, 550, 580, 560, 570, 570, 590, 660 and 545 cocoons for NB_7 and 675, 590, 595, 580, 560, 535, 545, 525, 545, 565, 530 and 532

cocoons for NB_{18} from April 1980 to March 1981 monthly rearings, respectively. The study indicated that the average weight of cocoons decreases during summer months starting from April till June.

Jolly et al. (1982) reported the weight relationship among various growth parameters of the silkworm larva viz. weight of matured silkworm, silkgland, cocoon and shell for different races viz. PM, HM, KA, NB_7, NB_{18}, PM X NB_{18} and NB_{18} X NB_7. All the parameters were found to be more in NB_{18} X NB_7 as 3.98, 1.633, 2.000 and 0.391 g and low in case of Pure Mysore as 1.80, 0.543, 0.903 and 0.154 g, respectively.

Mariswamy et al. (1982) obtained minimum number 606 and 660 cocoons per kg with NB_{18} and NB_4D_2 races, respectively during May 1981 and the maximum of 851 cocoons during December 1981 and 875 during October 1981 with NB_{18} and NB_4D_2, respectively.

Pillai and Raju (1982) found the variation in cocoon weight, shell weight and shell ratio as 1.538-1.945 g, 0.336-0.408 g and 21.04-21.89 per cent for

NB_7 and 1.612-1.960 g, 0.357-0.414 g and 20.78-22.23 per cent for NB_{18}, respectively.

Venugopal Pillai and Satyanarayan Raju (1982) reported that the cocoon weight, shell weight and shell percentages were high 2.328 g, 0.516 g and 22.2 per cent for NB_{18} and 2.024 g, 0.464 g and 22.9 per cent for NB_4D_2, respectively during September-October 1981 rearing compared to that of November-December 1981 and December 1981-January 1982, rearings.

A study in bivoltine seed area, Anekal, Bangalore indicated that the cocoon weight, shell weight and shell percentages were high 1.460 g, 0.285 g and 19.52 per cent for NB_{18} and 1.280 g, 0.240 g and 18.75 per cent for NB_4D_2 during June 1982, respectively and 1.389 g, 0.280 g and 20.15 per cent for NB_{18} and 1.526 g, 0.290 g and 19.00 per for NB_4D_2 during September 1982, respectively compared to that of January 1983 rearing (Anonymous, 1983b).

Kapila et al. (1983) found that the number of cocoons per kg weight was 559 and 648 during June and

July 1982, respectively for PM X NB_{18}, while PM X KA had 603 cocoon per kg during late summer (May) rearing and indicated that the conditions were more favourable in June rearing.

Narasimhanna et al. (1983) found the number of cocoons per kg was 435, 537, 454 and 434 in KA, NB_7, NB_{18} and NB_4D_2 respectively, while the least being for KA and NB_4D_2 followed by NB_7 and maximum for NB_{18}.

Sidhu (1983) tested the CSRTI-I to VII breeds and NS-1 to NS-14 breeds, the newly evolved multivoltines on large scale trials performed better with respect to all the economical parameters than that of the exotic breeds and local Pure Mysore race.

Tayade (1983) reported that one kg of Wai-4 (multivoltine) numbered 817 and 1125 cocoons during July-August 1978 and August-September 1978, respectively compared to that of PM X KA and PM X NB_4D_2 with 740 and 617 cocoons, respectively. The productivity of the former two races during September-October 1978 and latter one during January-February 1978, respectively.

Periaswamy and Radhakrishnan (1984) studied the performance of a white cocoon producing multivoltine Chinese race of Bombyx mori L., which race and its crosses with bivoltines proved superior in several aspects of economic characteristics than Pure Mysore and its crosses with bivoltines.

According to Ravi (1986) the cocoon weight of 1.322 g, shell weight of 0.314 g and shell percentage of 16.666 and 17.472 per cent were higher in PM X NB_4D_2 during winter (December to February), rainy (June to August) and winter and summer (March to May) rearings, respectively compared to that of PM X NB_{18}.

MATERIAL AND METHODS

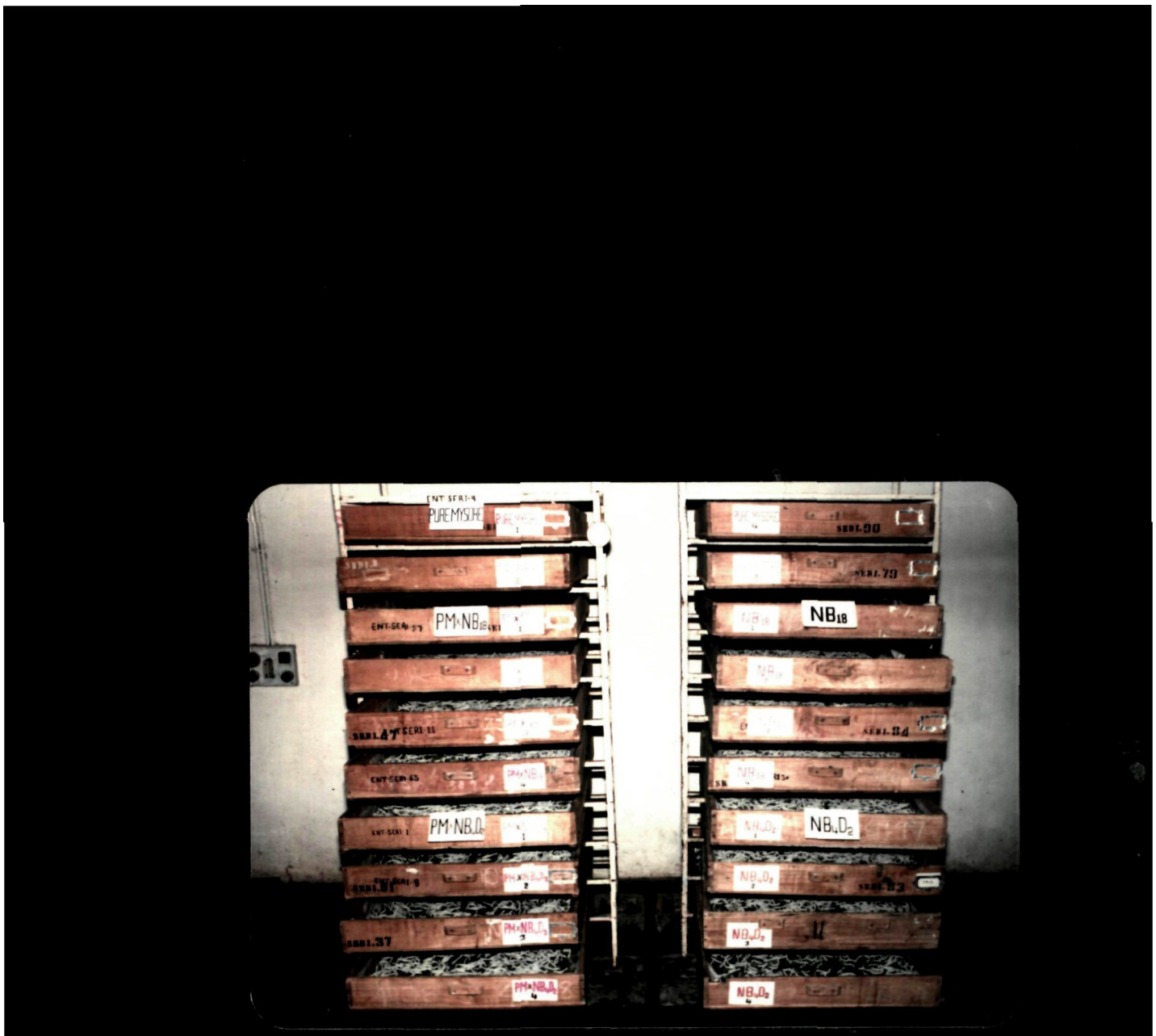

PLATE - 1

RESULTS

IV. RESULTS

Results of the study on performance of the selected races of silkworm Bombyx mori L. during different crop rearings (August-September 1985, December 1985-January 1986 and May-June 1986) in the Eastern Dry Zone of Karnataka are presented below.

The results of rearings are presented under three different headings.

A. First experiment - during August-September 1985

B. Second experiment - during December 1985-January 1986

C. Third experiment - during May-June 1986

4.1 Experiment-I (August-September 1985)

The first experimental rearing was conducted during August-September 1985, which period was marked with the mean maximum temperature of 26.64°C, mean minimum temperature of 17.42°C and the mean maximum relative humidity of 91.00 per cent and mean minimum relative humidity of 59.00 per cent inside the rearing room (Appendix I, IV) (Table 15).

4.1.1 Eggs hatchability

The number of eggs hatched from fifteen layings were 6405, 6282, 6247, 6241 and 6192 in PM X NB_4D_2, Pure Mysore, PM X NB_{18}, NB_{18} and NB_4D_2, respectively (Table 1). The number of eggs hatched was found to be maximum in the case of PM X NB_4D_2 closely followed by Pure Mysore and PM X NB_{18}, while it was low in the case of NB_4D_2.

The per cent hatched eggs ranged from 93.18 to 96.47 per cent. It was 96.47 for PM X NB_4D_2, 96.16 for Pure Mysore, 96.03 for PM X NB_{18}, 93.93 for NB_{18} and 93.18 for NB_4D_2 (Table 1). Maximum hatching percentage was observed in PM X NB_4D_2 followed by Pure Mysore, while it was low in the case of NB_4D_2 and NB_{18}.

4.1.2 Larval duration

The larval duration was 27.34 days for PM X NB_4D_2, 27.54 days for PM X NB_{18}, 28.29 days for NB_{18}, 28.45 days for NB_4D_2 and 29.58 days for Pure Mysore (Table 1, Figure 2). It was shorter for the cross

breeds (multivoltine X bivoltine) reared and the difference was significantly evident, but on par with each other. The larval duration was significantly longer for Pure Mysore than that of pure bivoltine races reared, which were on par with each other.

4.1.3 Silkworms survival/effective rate of rearing (ERR)

The number of silkworms survived from 15 layings and spun silk cocoons were 3722, 3511, 3449, 2647 and 2586 cocoons for PM X NB_4D_2, PM X NB_{18}, Pure Mysore, NB_{18} and NB_4D_2, respectively (Table 1). The effective rate of rearing ranged from 43.10 to 58.11 per cent. It was found to be maximum in the case of PM X NB_4D_2 (58.11 per cent), followed by PM X NB_{18} (56.20 per cent) and Pure Mysore (54.90 per cent), while it was minimum in the case of pure bivoltines viz., NB_{18} (43.10 per cent and NB_4D_2 (45.63 per cent) (Figure 3).

4.1.4 Crop loss

The per cent crop loss due to the incidence of

Table 1. Performance of the selected races of Bombyx mori L. on eggs hatchability, larval duration and effective rate of rearing (ERR) during August-September 1985

Races	Eggs hatched		Larval duration (days)	Worms survived (ERR)	
	Number	Per cent		Number	Per cent
Pure Mysore	6282	96.16	29.58[c]	3449	54.90
NB_{18}	6141	93.93	28.29[b]	2647	43.10
NB_4D_2	6192	93.18	28.45[b]	2586	45.63
PM X NB_{18}	6247	96.03	27.54[a]	3511	56.20
PM X NB_4D_2	6405	96.47	27.34[a]	3792	58.11
F-test	-	-	*	-	-
C.D. (P=0.05)	-	-	0.53	-	-

* Significant
Mean values superscribed with the same alphabet are not significantly different.

pests and diseases viz., grasserie, kenchu and uzi fly infestation was 45.63, 42.87, 32.57, 30.27 and 29.58 per cent for NB_4D_2, NB_{18}, Pure Mysore, PM X NB_4D_2 and PM X NB_{18}, respectively (Table 11). The loss was found to be maximum in the case of bivoltines viz., NB_{18} and NB_4D_2, while it was minimum for cross breeds viz., PM X NB_{18} and PM X NB_4D_2, followed by Pure Mysore.

4.1.5 Larval weight

4.1.5.1 First instar

The average weight of I instar larvae was 0.0055 g, 0.0053 g, 0.0053 g, 0.0047 g and 0.0036 g for NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore respectively (Table 2). The difference in larval weight was significant. It was high in the case of NB_4D_2 but on par with NB_{18} and PM X NB_4D_2. While it was significantly low in the case of Pure Mysore than that of the cross breeds and bivoltine strains.

4.1.5.2 Second instar

The average weight of II instar larvae was 0.0608 g, 0.0594 g, 0.0581 g, 0.0577 g and 0.0407 g in NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore respectively (Table 2). In both the bivoltines viz. NB_{18}, NB_4D_2 and cross breed PM X NB_4D_2 the larval weight was significantly higher and superior to that of PM X NB_{18} and Pure Mysore.

4.1.5.3 Third instar

The average weight of III instar larvae was 0.2872 g for NB_4D_2, 0.2800 g for NB_{18}, 0.2680 g for PM X NB_4D_2, 0.2657 g for PM X NB_{18} and 0.1668 g for Pure Mysore, respectively (Table 2). The difference in larval weight was significantly evident. The two bivoltine races were on par with each other, but superior to the other races. The weight was significantly low for Pure Mysore compared to bivoltines and the cross breeds.

4.1.5.4 Fourth instar

The average weight of IV instar larvae was 1.7667 g, 1.7537 g, 1.6035 g, 1.5812 g and 0.9885 g in the cases of NB_{18}, NB_4D_2, PM X NB_{18}, PM X NB_4D_2 and Pure Mysore, respectively (Table 2). Similarly, the bivoltine strains were on par with each other, but significantly superior to other races. While it was significantly low in the case of Pure Mysore than that of the bivoltines and cross breeds.

4.1.5.5 Fifth instar

The average weight of V instar larvae was 7.0492 g for NB_4D_2, 6.9785 g for NB_{18}, 6.4987 g for PM X NB_{18}, 6.3592 g for PM X NB_4D_2 and 5.4730 g for Pure Mysore (Table 2). In both the bivoltines races the larval weight was on par with each other, but significantly superior to other races. While it was significantly low in the case of Pure Mysore than that of the bivoltine races and cross breeds.

4.1.5.5 Ripened larvae

The average weight of ripened larvae was 34.0432 g, 33.9465 g, 25.1350 g, 27.1012 g and 17.909 g in NB_4D_2, NB_{18} PM X NB_4D_2, PM X NB_{18} and Pure Mysore race, respectively (Table 2). The larval weight for pure bivoltine races was significantly higher than the cross breeds tried, while it was significantly low in Pure Mysore.

4.1.6 Cocoon yield

The mean yield per replication from 15 layings was 1.0187 kg for PM X NB_4D_2, 0.9587 kg for PM X NB_{18}, 0.8050 kg for Pure Mysore and 0.7900 kg cocoon for NB_4D_2 (Table 12). The difference in cocoon yield was significantly high in PM X NB_4D_2, while it was significantly low in case of NB_4D_2 than that of the other races tried, including the multivoltine race.

The calculated cocoon yield per 100 layings was 27.166 kg, 25.566 kg, 22.000 kg, 21.466 kg and

Table 2. Weight of ten larvae in the selected races of B. mori L. during August-September 1985.

Races	Weight of silkworms (g)					
	I instar	II instar	III instar	IV instar	V instar	Ripened larvae
Pure Mysore	0.0036^{c}	0.0407^{b}	0.1668^{b}	0.9885^{c}	5.4730^{c}	17.9090^{c}
NB_{18}	0.0053^{a}	0.0594^{a}	0.2800^{a}	1.7667^{a}	6.9785^{a}	33.9465^{b}
NB_4D_2	0.0055^{a}	0.0605^{a}	0.2872^{a}	1.7537^{a}	7.0492^{a}	34.0432^{a}
PM X NB_{18}	0.0047^{b}	0.0577^{a}	0.2657^{a}	1.6035^{b}	6.4987^{b}	27.1012^{d}
PM X NB_4D_2	0.0050^{ab}	0.0581^{a}	0.2680^{a}	1.5812^{b}	6.3592^{b}	28.1350^{e}
F-test	*	*	*	*	*	*
C.D. (P=0.05)	0.0005	0.0030	0.0285	0.0398	0.4330	0.4202

*Significant

Mean values superscribed with the same alphabet are not significantly different.

21.066 kg in the cases of PM X NB_4D_2, PM X NB_{18}, Pure Mysore and NB_4D_2 respectively (Table 12, Figure 4). The cocoon yield productivity was found to be high in the case of cross breeds viz PM X NB_4D_2, followed by PM X NB_{18}. While it was low in NB_4D_2 and Pure Mysore, during the rainy month.

4.1.7 Cocoon characteristics

4.1.7.1 Number to weight of cocoons

The number of cocoons per 100 g weight, was 69, 71, 82, 85 and 109 in NB_4D_2, NB_{18}, PM X NB_4D_2, NB_7 X NB_{18} and Pure Mysore, respectively (Table 12). The number to weight of cocoons was found to be significantly superior in NB_4D_2 and on par with NB_{18}, while it was poor in the case of Pure Mysore.

4.1.7.2 Cocoon weight

The average weight of single cocoon was 1.7897 g for NB_4D_2, 1.7035 g for NB_{18}, 1.6072 g

for PM X NB_4D_2, 1.5890 g for PM X NB_4D_2 and 0.9590 g for Pure Mysore (Table 3) and the difference was significantly evident. The cocoon weight was significantly high in the case of NB_4D_2, while it was significantly low for the Pure Mysore than that of the other races tried.

4.1.7.3 Shell weight

The average shell weight was 0.3372 g for NB_4D_2 0.3117 g for NB_{18}, 0.2777 g for PM X NB_4D_2, 0.2625 g for PM X NB_{18} and 0.1220 g for Pure Mysore (Table 3) and the difference among each race or strain was significant. The shell weight was found to be significantly high in NB_4D_2, while it was low for Pure Mysore compared to other races tried.

4.1.7.4 Shell percentage

The shell percentage was found to vary from 12.71 to 18.84 among the different races or strains tried. It was 18.84, 18.29, 17.28, 16.51 and 12.71

per cent in NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore respectively (Table 3). The shell per cent was significantly more in the case of NB_4D_2 and on par with NB_{18}, while it was significantly low for Pure Mysore.

4.1.7.5 Pupal weight

The average weight of pupa was 1.4407 g for NB_4D_2, 1,3617 g for NB_{18}, 1.3160 g for PM X NB_{18}, 1.2945 g for PM X NB_4D_2 and 0.8257 g for Pure Mysore (Table 3). The weight of pupa was maximum in NB_4D_2 and on par with NB_{18} but significantly superior to that of other races reared, while it was significantly low for Pure Mysore.

4.1.7.6 Filament length

The length of the individual reelable filament was 751.75, 733.75, 685.00, 670.50 and 413.00 m for NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure

Table 3. Performance of the selected races of B. mori L. in respect of the economic parameters of silk cocoon during August-September 1985.

Races	Cocoon weight (g)	Shell weight (g)	Shell percentage	Pupal weight (g)	Filament length (m)	Denier
Pure Mysore	0.9590^{d}	0.1220^{e}	12.71^{d}	0.8257^{d}	413.00^{c}	1.86^{c}
NB_{18}	1.7035^{b}	0.3117^{b}	18.29^{a}	1.3617^{b}	733.75^{a}	2.64^{a}
NB_4D_2	1.7897^{a}	0.3372^{a}	18.84^{a}	1.4407^{a}	751.75^{a}	2.73^{a}
PM X NB_{18}	1.5890^{c}	0.2625^{d}	16.51^{c}	1.3160^{c}	670.50^{b}	2.48^{b}
PM X NB_4D_2	1.6072^{c}	0.2777^{c}	17.28^{b}	1.2945^{c}	685.00^{b}	2.52^{ab}
F-test	*	*	*	*	*	*
C.D.(P=0.05)	0.0260	0.0134	0.58	0.0436	30.86	0.12

* Significant

Mean values superscribed with the same alphabet are not significantly different.

Mysore, respectively (Table 3). The filament length was significantly more in NB_4D_2 and on par with NB_{18}, while it was significantly low for Pure Mysore compared to other races reared.

4.1.7.7 Denier

The denier was found to be vary from 1.86 to 2.73 among the different races reared. It was 2.73, 2.64, 2.52, 2.48 and 1.86 in the cases of NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 3). Maximum denier was the for NB_4D_2 and it was significantly superior, while it was significantly poor in the case of Pure Mysore than that of the other races tried.

4.2 Experiment II (December 1985 - January 1986)

The second experimental rearing was conducted during December 1985 - January 1986, which period was marked with mean maximum temperature of 26.82°C, mean minimum temperature of 13.52°C and the mean maximum

relative humidity of 87.14 per cent and mean minimum relative humidity of 46.02 per cent was noticed (Appendix II, V) (Table 15).

4.2.1 Eggs hatchability

The number of eggs hatched from fifteen layings were 6,293, 6,200, 6,168, 6,135 and 6,116 in the cases of NB_4D_2, NB_{18}, Pure Mysore, PM X NB_4D_2 and PM X NB_{18}, respectively (Table 4). The number of eggs hatched was found maximum in the case of NB_4D_2, followed by NB_{18}, while it was low in PM X NB_{18} than that of the other races reared.

The per cent hatchability was 95.73, 94.98, 94.78, 93.72 and 93.70 per cent in Pure Mysore, PM X NB_4D_2 PM X NB_{18} NB_{18} and NB_4D_2, respectively (Table 4). Maximum hatchability was observed in Pure Mysore followed by PM X NB_4D_2 and PM X NB_{18}, while it was low in the case of bivoltine races viz., NB_{18} and NB_4D_2, compared to that of multivoltine and cross breeds.

4.2.2 Larval duration

The larval duration ranged from 28.24 to 30.41 days among the silkworm races reared. It was 28.24, 28.95, 29.37, 29.66 and 30.41 days in PM X NB_4D_2, PM X NB_{18} NB_{18}, NB_4D_2 and Pure Mysore, respectively (Table 4, Figure 2). The larval duration was found to be minimum in the case of PM X NB_4D_2, while it was significantly high in Pure Mysore compared to that of other races tried.

4.2.3 Silkworm survival/Effective Rate of Rearing (ERR)

The number of silkworms survived and spun cocoons from fifteen layings were 3,728, 3,593, 3,545, 2,486 and 2,270 in PM X NB_4D_2, PM X NB_{18}, Pure Mysore, NB_{18} and NB_4D_2, respectively (Table 4). The effective rate of rearing (ERR) ranged from 36.07 to 60.76 per cent. It was 60.76, 58.74, 54.47, 40.09 and 36.07 per cent in PM X NB_4D_2, PM X NB_{18} Pure Mysore NB_{18} and NB_4D_2, respectively (Figure 3). The ERR was maximum in the cross breeds reared, while it was minimum in the bivoltine viz. NB_{18} and NB_4D_2 reared.

Table 4. Performance of the selected races of B. mori L. on eggs hatchability, larval duration and effective rate of rearing during December 1985-January 1986.

Races	Eggs hatched		Larval duration (days)	Worms survived (ERR)	
	Number	Per cent		Number	Per cent
Pure Mysore	6168	95.73	30.41^{d}	3545	54.47
NB_{18}	6200	93.72	29.37^{c}	2486	40.09
NB_4D_2	6293	93.70	29.66^{c}	2270	36.07
PM X NB_{18}	6116	94.78	28.95^{b}	3593	58.74
PM X NB_4D_2	6135	94.98	28.24^{a}	3728	60.76
F-test	-	-	*	-	-
C.D. (P=0.05)	-	-	0.38	-	-

* Significant

Mean values superscribed with the same alphabet are not significantly different.

4.2.4 Crop loss

The cocoon crop loss due to incidence of diseases and pests viz., grasserie, flacherie, muscardine and Indian uzi fly infestation was 53.22, 47.39, 31.65, 29.94 and 26.82 per cent in the case of NB_4D_2, NB_{18} Pure Mysore, PM X NB_{18} and PM X NB_4D_2, respectively (Table 11). The crop loss was found to be maximum in bivoltine races viz., NB_4D_2 and NB_{18}, while it was comparatively less in cross breeds viz., PM X NB_{18} and PM X NB_4D_2.

4.2.5 Larval weight

4.2.5.1 First instars

The average weight of I instar larvae was 0.0056 g, 0.0056 g, 0.0052 g, 0.0052 g and 0.0038 g in the cases of NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 5). The larval weight was maximum in the case of NB_4D_2 and NB_{18} and significantly superior to the other races,

while it was significantly low in the case of Pure Mysore.

4.2.5.2 Second instar

The average weight of II instar larvae was 0.0650 g for NB_4D_2, 0.0618 g for PM X NB_{18}, 0.0616 g for NB_4D_2, 0.00615 g for NB_{18}, and 0.0431 g for Pure Mysore (Table 5). The larval weight was found to be significantly high in NB_4D_2, while it was significantly low in the case of Pure Mysore compared to that of other races.

4.2.5.3 Third instar

The average weight of II instar larvae was 0.3017 g, 0.2908 g, 0.2847 g, 0.2815 g and 0.1707 g in NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 5). The difference in larval weight was found maximum for NB_4D_2 and on par with NB_{18}, while it was significantly low in the case of Pure Mysore.

4.2.5.4 Fourth instar

The average weight of IV instar larvae was 1.8152 g, 1.8117 g, 1.6142 g, 1.6085 g and 1.000 g for NB_{18}, NB_4D_2, PM X NB_{18}, PM X NB_4D_2 and Pure Mysore, respectively (Table 5). The larval weight in both the bivoltine strains was on par with each other but significantly superior to the other races reared, while it was significantly low for Pure Mysore.

4.2.5.5 Fifth instar

The average weight of V instar larva was 7.1457 g, 6.9857 g, 6.1785 g, 6.1450 g and 5.5762 g in the cases of NB_4D_2, NB_{18}, PM X NB_{18}, PM X NB_4D_2 and Pure Mysore, respectively (Table 5). The larval weight was significantly high in both the bivoltine strains and on par with each other, while it was significantly low in the case of Pure Mysore than that of the bivoltine and cross breeds.

4.2.5.6 Ripened larvae

The average weight of ripened larva was

Table 5. Weight of ten larvae in the selected races of B. mori L. during December 1985-January 1986

Races	Weight of silkworms (g)					
	I instar	II instar	III instar	IV instar	V instar	Ripened larvae
Pure Myosre	0.0038^{b}	0.0431^{c}	0.1707^{d}	1.0000^{c}	5.5762^{c}	18.3492^{c}
NB_{18}	0.0056^{a}	0.0615^{b}	0.2980^{ab}	1.8152^{a}	6.9857^{a}	34.4450^{a}
NB_4D_2	0.0056^{a}	0.0650^{a}	0.3017^{a}	1.8117^{a}	7.1457^{a}	34.8117^{a}
PM X NB_{18}	0.0052^{a}	0.0618^{b}	0.2815^{c}	1.6142^{b}	6.1785^{b}	29.0792^{b}
PM X NB_4D_2	0.0052^{a}	0.0616^{b}	0.2847^{b}	1.6085^{b}	6.1460^{b}	29.5197^{b}
F-test	*	*	*	*	*	*
C.D. (P=0.05)	0.0008	0.0023	0.0164	0.0621	0.3865	0.6380

* Significant
Mean values superscribed with the same alphabet are not significantly different.

34.8117 g, 34.4450 g, 29.5197 g, 29.0792 g and 18.3492 g in the case of NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore respectively (Table 5). In both the bivoltine strains the larval weight was on par with other, but significantly superior to the other races, while it was significantly low for Pure Mysore compared to that of the other races reared.

4.2.6 Cocoon yield

The mean yield per replication from 15 layings was 0.9825 kg, 0.9125 kg, 0.7875 kg, 0.7662 kg and 0.7275 kg in PM X NB_4D_2, PM X NB_{18}, Pure Mysore, NB_4D_2 and NB_{18} respectively (Table 12). The cocoon yield was found significantly the highest in PM X NB_4D_2, while it was significantly the lowest in the case of NB_{18} compared to that of other races reared.

The cocoon yield projected for 100 layings ranged from 19.400 kg to 25-60 kg. It was 25.600 kg for PM X NB_4D_2, 24.333 kg for PM X NB_{18}, 21.000 kg for Pure Mysore, 20.433 kg for NB_4D_2 and 19.000 kg

for NB_{18}, (Table 12, Figure 4). The cocoon yield was found to be more in the case of cross breeds reared, while it was low for Pure bivoltine viz., NB_{18} and NB_4D_2.

4.2.7 Cocoon characteristics

4.2.7.1 Number of weight of cocoons

The number of cocoons per unit weight of 100 g varied anywhere from 68 to 108. It was 68, 73, 79, 80 and 108 in NB_4D_2, NB_{18}, PM X NB_{18}, PM X NB_4D_2 and Pure Mysore, respectively (Table 12). Both the bivoltine races were on par with each other but significantly superior to that of the other races, while it was significantly inferior in the case of Pure Mysore compared to the bivoltine races and the cross breeds.

4.2.7.2 Cocoon weight

The average weight of cocoon was 1.7657 g for NB_4D_2, 1.6907 g for NB_{18}, 1.6010 g for PM X NB_4D_2, 1.5992 g for PM X NB_{18} and 0.9310 g for Pure Mysore

(Table 6). The cocoon weight was maximum in the case of NB_{18} and significantly superior to that of other races, it was significantly low in the case of Pure Mysore.

4.2.7.3 Shell weight

The average shell weight of silk cocoons was 0.3302 g, 0.3097 g, 0.2737 g, 0.2646 g and 0.1182 g in the case of NB_4D_2, NB_{18} PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 6). The shell weight was high and significantly superior in NB_4D_2, while it was significantly low in the case of Pure Mysore than that of the bivoltine races and cross breeds.

4.2.7.4 Shell percentage

The average shell percentage was 18.70, 18.31, 17.10, 16.53 and 12.70 per cent in NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 6). In both the bivoltine strains the shell percentage was on par with each other, but significantly higher than that of the other races. It was

significantly low in the case of Pure Mysore than that of bivoltine races and cross breeds.

4.2.7.5 Pupal weight

The average weight of pupa was 1.4290 g for NB_4D_2, 1.3712 g for NB_{18}, 1.3250 g for PM X NB_{18}, 1.3185 g for PM X NB_4D_2 and 0.8027 g for Pure Mysore (Table 6). The difference in weight of pupa was found to be higher and significantly superior in the case of NB_4D_2, while it was significantly low in the case of the Pure Mysore compared to other races tried.

4.2.7.6 Filament length

The length of reelable silk filament was 751.75, 730.00, 681.25, 672.00 and 402.75 m. in the case of NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 6). The filament length was found to be maximum in both the bivoltine strains and on par with each other, but significantly superior to other races. It was significantly low in the case

Table 6. Performance of the selected races of B. mori L. in respect of the economic parameters of silk cocoons during December 1985-January 1986.

Races	Cocoon weight (g)	Shell weight (g)	Shell percentage	Pupal weight (g)	Filament length (m)	Denier
Pure Mysore	0.9310^{d}	0.1182^{d}	12.70^{d}	0.8027^{d}	402.75^{c}	1.79^{c}
NB_{18}	1.6907^{b}	0.3097^{b}	18.31^{a}	1.3712^{b}	730.00^{a}	2.62^{a}
NB_4D_2	1.7657^{a}	0.3302^{a}	18.70^{a}	1.4290^{a}	754.75^{a}	2.69^{a}
PM X NB_{18}	1.5992^{c}	0.2645^{c}	16.53^{c}	1.3250^{c}	672.00^{b}	2.47^{b}
PM X NB_4D_2	1.6010^{c}	0.2737^{c}	17.10^{b}	1.3185^{c}	681.25^{b}	2.53^{b}
F-test	*	*	*	*	*	*
C.D. (P=0.05)	0.0232	0.0094	0.39	0.0171	31.69	0.08

* Significant

Mean values superscribed with the same alphabet are not significantly different.

of Pure Mysore compared to the cross breeds and bivoltines reared.

4.2.7.7 Denier

The denier deviation was significantly was 2.69, 2.62, 2.55, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore respectively (Table 6). The denier was significantly high and superior in the case of NB_4D_2, while it was significantly low in the case of Pure Mysore than that of the other races tried.

4.3 Experiment III (May-June 1986)

The third experimental rearing was conducted during May-June 1986 and it was marked with mean maximum temperature of 32.24°C, mean minimum temperature of 21.15°C and the mean maximum and mean minimum relative humidity of 66.37 and 41.29 per cent, respectively (Appendix III, VI) (Table 15) inside the rearing room.

4.3.1 Eggs hatchability

The number of eggs hatched from fifteen layings was 6,039, 5,840, 5,778, 5,558, 5,400 in Pure Mysore, PM X NB_4D_2, PM X NB_{18}, NB_4D_2 and NB_{18}, respectively (Table 7). The number of eggs hatched was found maximum for Pure Mysore followed by PM X NB_4D_2 and PM X NB_{18}. However, it was minimum for Pure bivoltines viz. NB_{18} and NB_4D_2.

The per cent hatched ranged from 91.85 to 94.99 per cent. It was 94.99, 94.71, 94.68, 92.20 and 91.85 per cent in PM X NB_4D_2, Pure Mysore, PM X NB_{18}, NB_4D_2 and NB_{18}, respectively (Table 7). It was maximum in the case of PM X NB_4D_2, closely followed by Pure Mysore and PM X NB_{18}, while it was minimum in the Pure bivoltine races viz., NB_{18} and NB_4D_2 comparatively.

4.3.2 Larval duration

The larval duration was 26.67, 27.21, 27.67,

28.21 and 28.61 days in PM X NB_4D_2, PM X NB_{18}, NB_4D_2, NB_{18} and Pure Mysore, respectively (Table 7, Figure 2). The larval duration for PM X NB_4D_2 was significantly low to that of PM X NB_{18} and NB_4D_2 were on par with each other, while it was significantly high in the case of NB and Pure Mysore which were on par.

4.3.3 Silkworm survival/Effective rate of rearing (ERR)

The number of silkworms survived and spun cocoons from fifteen layings were 4,273, 3,875, 3,827, 2,701 and 2,504 in Pure Mysore, PM X NB_4D_2, PM X NB_{18}, NB_4D_2 and NB_{18} , respectively (Table 7). The effective rate of rearing ranged from 46.37 to 70.75 per cent among the different races reared. It was 70.75, 66.35, 66.23, 48.59 and 46.37 per cent in the cases of Pure Mysore, PM X NB_4D_2, PM X NB_{18}, NB_4D_2 and NB_{18}, respectively (Figure 3). The ERR was found maximum in the case of Pure Mysore and minimum in the bivoltines viz., NB_4D_2 NB_{18}.

Table 7. Performance of the selected races of B. mori L. on eggs hatchability, larval duration and effective rate of rearing during May-June 1986.

Races	Eggs hatched		Larval duration (days)	Worms survived (ERR)	
	Number	Per cent		Number	Per cent
Pure Mysore	6039	94.71	28.62[c]	4273	70.75
NB_{18}	5400	91.85	28.21[c]	2504	46.37
NB_4D_2	5558	92.20	27.67[b]	2701	48.59
PM X NB_{18}	5778	94.68	27.21[b]	3827	66.29
PM X NB_4D_2	5840	94.99	26.67	23875	66.35
F-test	-	-	*	-	-
C.D. (P=0.05)	-	-	0.47	-	-

* Significant

Mean values superscribed with the same alphabet are not significantly different.

4.3.4. Cocoon crop loss

The cocoon crop loss due to incidence of diseases and pests viz., grasserie, flacherie and Indian uji fly infestation was 45.67, 41.21, 26.71, 26.71, 26.46 and 23.14 per cent in NB_{18}, NB_4D_2, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 11). The crop loss was found to be more in the pure bivoltine viz., NB_{18} and NB_{18}, while it was minimum in Pure Mysore followed by cross breeds viz., PM X NB_{18} and PM X NB_4D_2 comparatively.

4.3.5 Larval weight

4.3.5.1 First instars

The average weight of I instar larvae was 0.0057 g, 0.0056 g, 0.0055 g, 0.0053 g and 0.0041 g in the case of NB_4D_2, NB_{18}, PM X NB_{18}, PM X NB_4D_2 and Pure Mysore, respectively (Table 8). The difference in larval weight was found to be significant it was high in both the bivoltines and cross breeds which were on par and significantly superior to Pure Mysore.

4.3.2.2 Second instar

The average weight of II instar larvae was 0.0622 g for NB_4D_2, 0.0587 g for NB_{18}, 0.0587 g for PM X NB_4D_2, 0.0545 g PM X NB_{18} and 0.0542 g for Pure Mysore (Table 8). The difference in larval weight was significantly evident. It was high for NB_4D_2 and low in the case of Pure Mysore and PM X NB_{18} and on par with each other.

4.3.2.3 Third instar

The average weight of III instar larvae was 0.3020 g, 0.2955 g, 0.2797 g, 0.2627 g and 0.1792 g in the case of NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 8). The larval weight was found to be maximum in NB_4D_2 and on par with NB_{18} and PM X NB_4D_2, and the difference was significant, while it was significantly low in the case of Pure Mysore compared to that of the pure bivoltines and the cross breeds.

4.3.2.4 Fourth instar

The average weight of IV instar larvae was 1.7982 g for NB_4D_2, 1.7965 g for NB_{18}, 1.6085 g for PM X NB_4D_2, 1.5957 g for PM X NB_{18} and 1.0037 g for Pure Mysore (Table 8). In both the bivoltine races the larval weight was on par with each other but significantly superior to other races, while it was significantly low in the case of Pure Mysore compared to the cross breeds and bivoltine races.

4.3.2.5 Fifth instar

The average weight of V instar larvae was 7.0720 g for NB_4D_2, 6.9950 g for NB_{18}, 6.7530 g for PM X NB_4D_2, 6.1700 g for PM X NB_{18} and 5.5745 g for Pure Mysore, (Table 8). The gain in larval weight was significantly high in the case of NB_4D_2 and on par with NB_{18}, while it was significantly low in the case of Pure Mysore than that of the other races reared.

4.3.5.6 Ripened larva

The average weight of ripened larvae was

Table 8. Weight of ten larvae in the selected races of B. mori L. during May-June 1986.

Races	Weight of silkworms (g)					
	I instar	II instar	III instar	IV instar	V instar	Ripened larvae
Pure Mysore	0.0041^{b}	0.0542^{a}	0.1792^{c}	1.0037^{c}	5.5745^{d}	18.1402^{e}
NB_{18}	0.0056^{a}	0.0587^{b}	0.2985^{ab}	1.7965^{a}	6.9950^{ab}	34.2980^{b}
NB_4D_2	0.0057^{a}	0.0622^{a}	0.3020^{a}	1.7982^{a}	7.0720^{a}	35.3160^{a}
PM X NB_{18}	0.0055^{a}	0.0545^{c}	0.2627^{b}	1.5957^{b}	6.1700^{c}	28.2397^{d}
PM X NB_4D_2	0.0053^{a}	0.0587^{b}	0.2797^{ab}	1.6085^{b}	6.7530^{b}	28.8102^{c}
F-test	*	*	*	*	*	*
C.D. (P=0.05)	0.0006	0.0018	0.0336	0.0252	0.3304	0.4594

* Significant

Mean values superscribed with the same alphabet are not significantly different.

35.3160 g, 34.2980 g, 28.8102 g, 28.2397 g and 18.1404 g in NB_4D_2 NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 8). The larval weight was found to be significantly high in for NB_4D_2, followed by NB_{18} while it was significantly low in the case of Pure Mysore compared to the cross breeds reared. Notable differences existed among the cross breeds also.

4.3.6 Cocoon yield

The mean cocoon yield per replication from fifteen layings was 1.163 kg, 1.100 kg, 0.975 kg, 0.925 kg and 0.865 kg in the case of PM X NB_4D_2, PM X NB_{18}, Pure Mysore, NB_4D_2 and NB_{18}, respectively (Table 12). The yield was found to be more in PM X NB_4D_2 and the difference was significantly evident. It was significantly low in the case of NB_{18} compared to that of other races reared.

The cocoon yield projected to 100 layings was 31.00 kg, 29.33 kg, 26.00 kg, 24.66 kg and 23.03 kg in the case of PM X NB_4D_2, PM X NB_{18}, Pure

Mysore, NB_4D_2 and NB_{18}, respectively (Figure 4). The yield was found to be high in both the cross breeds while it was low in the case of bivoltine races compared to that of Pure Mysore.

4.3.7 Cocoon characteristics

4.3.7.1 Cocoon weight

The average cocoon weight was 1.7847 g, 1.7045 g, 1.6052 g, 1.6027 and 0.9377 g in NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18}, and Pure Mysore, respectively (Table 9). The single cocoon weight was found to be maximum in NB_4D_2 and significantly superior to that of NB_{18} and the other races, while it was significantly low in the case of Pure Mysore and inferior to PM X NB_4D_2 and PM X NB_{18} and the latter were on par with each other.

4.3.7.2 Shell weight

The average shell weight was 0.3885 g for NB_4D_2, 0.3165 g for NB_{18}, 0.2782 g for PM X NB_4D_2, 0.2730 g for PM X NB_{18} and 0.1245 g for Pure Mysore

(Table 9). The shell weight was found to be maximum in NB_4D_2 and significantly superior to NB_{18} and the other races, while it was significantly low in the case of Pure Mysore compared to that of PM X NB_{18} and PM X NB_4D_2 which were on par with each other.

4.3.7.3 Shell percentage

The average shell per cent was 19.05, 18.56, 17.33, 16.99 and 13.26 per cent in the case of NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 9). The shell percentage was significantly high in NB_4D_2 and superior to NB_{18} and other races reared, while it was significantly low in the case of Pure Mysore and inferior to that of cross breeds viz. PM X NB_{18}, PM X NB_4D_2 which were on par with each other.

4.3.7.4 Pupal weight

The average weight of pupa was 1.4350 g for NB_4D_2, 1.3930 g for NB_{18}, 1.3275 g for PM X NB_{18},

1.3235 g for PM X NB_4D_2 and 0.8107 g for Pure Mysore (Table 9). In both the bivoltine races viz., NB_{18}, NB_4D_2, the pupal weight was significantly superior to that of cross breeds, while it was significantly low and inferior in the case of Pure Mysore.

4.3.7.5 Filament length

The average length of the individual reelable silk filament was 768.60 m, 744.25 m, 693.00 m, 678.50 m and 425.00 m in the case of NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 9). The filament length was found to be significantly more in the bivoltine races viz., NB_4D_2, NB_{18} and on par with each other, but superior to that of cross breeds, while it was significantly low in the case of Pure Mysore.

4.3.7.6 Denier

The denier deviation was significantly evident among the silkworm races reared. It was 2.80, 2.72,

Table 9. Performance of the selected races of B. mori L. in respect of the economic parameters of silk cocoon during May-June 1986.

Races	Cocoon weight (g)	Shell weight (g)	Shell percentage (%)	Pupal weight (g)	Filament length (m)	Denier
Pure Mysore	0.9377[d]	0.1245[d]	13.26[c]	0.8107[d]	425.00[c]	1.97[c]
NB_{18}	1.7045[b]	0.3165[b]	18.56[a]	1.3930[b]	744.25[a]	2.72[a]
NB_4D_2	1.7847[a]	0.3385[a]	19.05[a]	1.4350[a]	768.50[a]	2.80[a]
PM X NB_{18}	1.6027[c]	0.2730[c]	16.99[b]	1.3275[c]	678.50[b]	2.49[b]
PM X NB_4D_2	1.6052[c]	0.2782[c]	17.33[b]	1.3235[c]	693.00[b]	2.54[b]
F-test	*	*	*	*	*	*
C.D. (P=0.05)	0.0145	0.0093	0.63	0.0106	34.35	0.11

* Significant

Mean values superscribed with the same alphabet are not significantly different.

2.54, 2.49 and 1.87 in NB_4D_2, NB_{18}, PM X NB_4D_2, PM X NB_{18} and Pure Mysore, respectively (Table 9). In both the bivoltine races, the denier was significantly more and on par with each other, but superior to that of (multivoltine X bivoltine) cross breeds, while it was significantly low and inferior in the case of Pure Mysore.

4.4 Overall performance of the selected races of *B. mori* L. during different rearings

During the experimental rearings, the mean maximum temperature was 32.24°C during May-June 1986 and mean minimum temperature (13.52°C) during December 1985-January 1986. The mean relative humidity was found to be maximum (91.00 per cent) during August-September 1985 and minimum (41.29 per cent) during May-June 1986 .

4.4.1 Eggs hatchability

The per cent hatchability was found to be maximum in the case of PM X NB_4D_2 (96.47 per cent)

and minimum in the case of NB_4D_2 (93.18 per cent) during August-September 1985. In the December 1985-January 1986 rearing it was maximum for Pure Mysore (95.73 per cent) and minimum for NB_4D_2 (93.70 per cent), while the hatchability was maximum in the case of PM X NB_4D_2 (94.99 per cent) and minimum in the case of NB_{18} (91.35 per cent) during May-June 1986 rearing (Table 10).

4.4.2 Weight of ripened larva

The average weight of the normal ripened larva was significantly high for NB_4D_2 in all the three rearings. It was 3.4043 g, 3.4811 g and 3.5316 g during August-September 1985, December 1985-January 1986 and May-June 1986 respectively, but on par with NB_{18} (3.444g) during December 1985-January 1986 (Table 10). The larval weight was least in the case of Pure Mysore with 1.7909 g, 1.8349 g and 1.8140 g during August-September 1986, December 1985-January 1986 and May-June 1986, respectively.

4.4.3 Larval duration

The larval duration was significantly low for PM X NB_4D_2 in all the three rearings, compared to other races reared. It was 27.34, 28.24 and 26.67 days during August-September 1985, December 1985-January 1986 and May-June 1986 respectively, but on par with PM X NB_{18} (27.54 days) during August-September 1985. The larval duration was maximum in the case of Pure Mysore in all the three rearings, but on par with NB (28.21 days) during May-June 1986 (Table 10, Figure 2).

4.4.4 Effective rate of rearing (ERR)

The effective rate of rearing was found to be maximum in the case of PM X NB_4D_2 (58.11 per cent) during August-September 1985 and minimum in the case of NB_{18} (43.10 per cent). During December 1985-January 1986 the ERR for PM X NB_4D_2 (60.76 per cent) was maximum, while it was for less in the case of NB_{18} (36.07 per cent). On the other hand, the effective rate of

Table 10. Performance of the selected races of B. mori L. in respect of hatchability, matured larval weight, larval duration and effective rate of rearing during rearings

Races	Per cent hatchability			Wt. of 10 ripened larvae (g)			Larval duration (days)			Per cent survived (ERR)		
	Aug.-Sept. 1985	Decr.85-Janr.86	May - June 86	August-Septr.95	Decr.85-Janr.86	May-June 86	Aug.-Sept.85	Decr.85-Jan.86	May-June 86	Aug.-Sept.85	Dec.85-Jan.86	May-June 86
Pure Mysore	96.16	95.73	94.71	1.79090^{e}	1.83492^{c}	1.81402^{e}	29.58^{c}	30.41^{d}	28.62^{c}	54.90	54.47	70.75
NB_{18}	93.93	93.72	91.35	3.49465^{b}	3.44450^{a}	3.42980^{b}	28.29^{b}	29.37^{c}	28.21^{c}	43.10	40.09	46.37
NB_4D_2	93.18	93.70	92.20	3.40432^{a}	3.48117^{a}	3.53160^{a}	28.45^{b}	29.66^{c}	27.67^{b}	45.63	36.07	48.59
P1 X NB_{18}	96.03	94.78	94.68	2.71012^{d}	2.90792^{b}	2.82397^{d}	27.54^{a}	28.95^{b}	27.21^{b}	56.20	58.74	66.23
P1 X NB_4D_2	96.47	94.98	94.99	2.81350^{c}	2.95197^{b}	2.88102^{c}	27.34^{a}	28.24^{a}	26.67^{a}	58.11	60.76	66.35
F-test	-	-	-	*	*	*	*	*	*	-	-	-
CD.(P=0.05)	-	-	-	0.4202	0.6308	0.4594	0.53	0.38	0.47	-	-	-

* Significant

Mean values superscribed with the same alphabet are not significantly different.

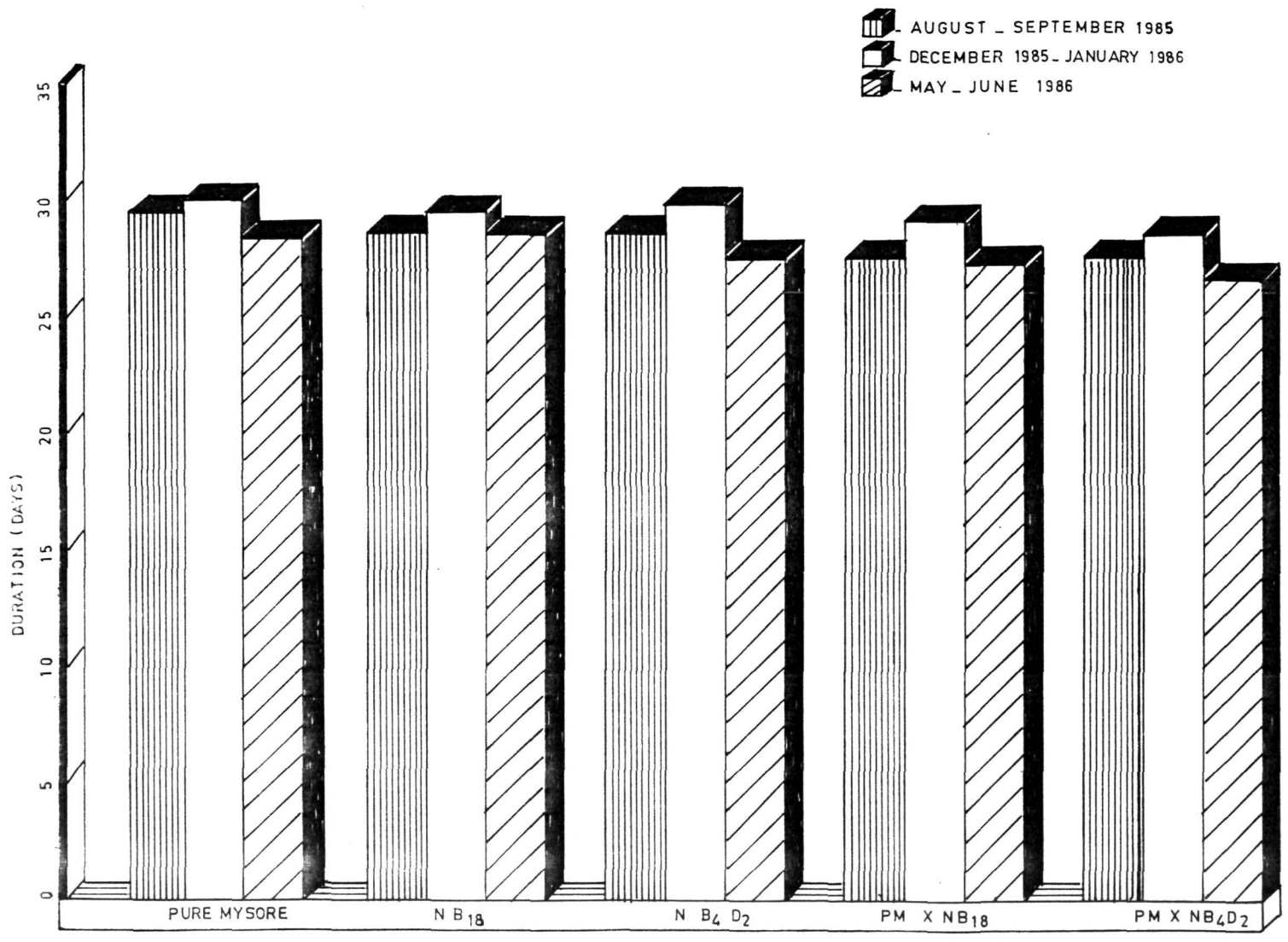

FIG.2: LARVAL DURATION OF THE MULBERRY SILKWORM RACES IN EASTERN DRY ZONE _ KARNATAKA.
(UAS, BANGALORE)

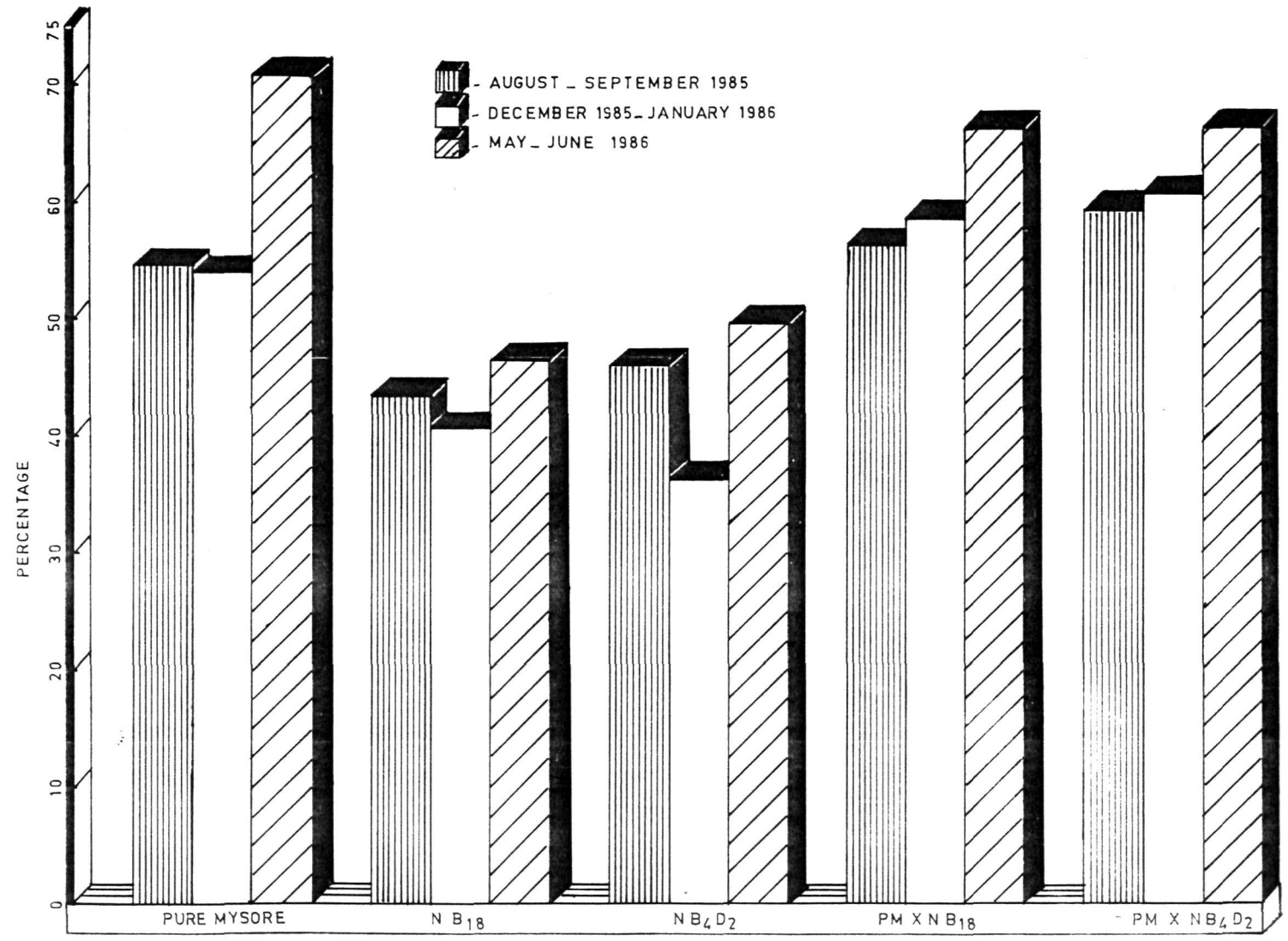

FIG. 3: EFFECTIVE RATE OF REARING OF THE MULBERRY SILKWORM RACES IN EASTERN DRY ZONE _ KARNATAKA. (UAS, BANGALORE)

rearing was maximum in Pure Mysore (70.75 per cent) and it was minimum in NB_{18} (46.37 per cent) during May-June 1986 compared to other races tried (Table 10, Figure 3).

4.4.5 Crop loss due to diseases and pests

In all the three rearings, crop loss was mainly due to silkworm diseases followed by the Indian Uzi fly. In the first rearing (August-September 1985) the combined loss ranged from 29.58 to 45.63 per cent, being minimum for PM X NB_{18} and the maximum for NB_4D_2. Of the diseases prevailing, grasserie followed by flacherie dominated the scene. In the second (December 1985-January 1986) and third rearing (May-June 1986) the observations at 5th instar revealed that the per cent loss (death of silkworms) due to Uzi fly infestation ranged from 10.77 to 12.33 and 8.38 to 11.72, respectively (Table 11). In the second rearing the incidence of white muscardine disease Beanvaria bassiana was observed to be high followed by grasserie and flacherie in all the races, tried. In 5th instar, the multivoltine race viz. Pure Mysore was found to be preferred by the Indian Uzi fly

Table 11. Per cent crop loss due to diseases and pests* during different rearings.

Races	Per cent crop loss due to				
	(August-September 1985)	December 1985-January 1986		May-June 1986	
	Diseases and pests*	Diseases	Pests*	Diseases	Pests*
Pure Mysore	32.57	19.32	12.33	11.97	11.17
NB_{18}	42.87	36.14	11.25	35.88	9.79
NB_4D_2	45.63	42.34	10.88	32.31	8.90
PM X NB_{18}	29.58	18.60	11.34	17.08	9.38
PM X NB_4D_2	30.27	16.05	10.77	16.66	10.55

* Indian Uzi fly infestation

compared to the other races in both the rearings studied.

4.4.6 Cocoon yield

The mean cocoon yield was significantly high in the case of PM X NB_4D_2 (1.0187 kg) and it was significantly low in the case of NB_4D_2 (0.7900 kg) during August-September 1985 rearing. On the other hand, the mean yield was significantly high for PM X NB_4D_2 (0.9825 kg and 1.1630 kg) during December 1985-January 1986 and May-June 1986, respectively, while it was significantly low in the case of NB_{18} with 0.7275 kg and 0.8650 kg during December 1985-January 1986 and May-June 1986, respectively (Table 12).

The cocoon yield calculated to 100 layings was maximum for PM X NB_4D_2 in all the three rearings, followed by PM X NB_{18}. It was 27.666 kg, 25.660 kg and 31.000 kg for PM X NB_4D_2 while for PM X NB_{18} 25.566, 24.330 and 29.330 kg during August-September 1985, December 1985-January 1986 and May-June 1986,

respectively (Table 12). The maximum productivity for both the cross breeds tried was during May-June 1986. The cocoon yield was low for the pure bivoltines during December 1985-January 1986 and May-June 1986 compared to Pure Mysore. Among the pure bivoltine tried NB_{18} faired better in the first (August-September 1985) rearing, while NB_4D_2 faired better in second (December 1985-January 1986) and third (May-June 1986) rearings (Table 13). Yield performance of all the races tried was almost similar in the first and third rearing, and the yield component was much higher in the third rearing (Figure 4).

4.4.7 Cocoon weight

The average single cocoon weight was found to be significantly high for NB_4D_2 in all the three rearings. It was 1.7898 g, 1.7657 g and 1.7847 g during August-September 1985, December 1985-January 1986 and May-June 1986, respectively. On the other hand, the cocoon weight was significantly low for Pure Mysore compared to the other races in all the three rearings.

Table 12. Cocoon yield of the selected races of silkworm B. mori during different crop rearings

Races	Cocoon yield (kg)								
	August-September 1985			December 85-January 1986			May-June 1986		
	Mean yield	Projected to 100 layings	No. of cocoons in 100 g.	Mean yield	Projected to 100 layings	No. of cocoons in 100 g	Mean yield	Projected to 100 layings	No. of cocoons in 100 g
Pure Mysore	0.8050^{cd}	21.466	109^{c}	0.7875^{c}	21.000	108^{c}	0.9750^{c}	26.000	108^{c}
NB_{18}	0.8287^{c}	22.100	71^{a}	0.7275^{d}	19.400	73^{a}	0.8550^{e}	23.030	70^{a}
NB_4D_2	0.7900^{d}	21.066	69^{a}	0.7662^{c}	20.433	68^{a}	0.9250^{d}	24.660	67^{a}
PM X NB_{18}	0.9587^{b}	25.566	85^{b}	0.9125^{b}	24.333	79^{b}	1.1000^{b}	29.330	79^{b}
PM X NB_4D_2	1.0187^{a}	27.166	82^{b}	0.9825^{a}	25.533	80^{b}	1.1630^{a}	31.000	78^{b}
F-test	*	-	*	*	-	*	*	-	*
C.D. (P=0.05)	0.0297	-	5.51	0.0213	-	5.58	0.0277	-	5.45

* Significant

Mean values superscribed with the same alphabet are not significantly different.

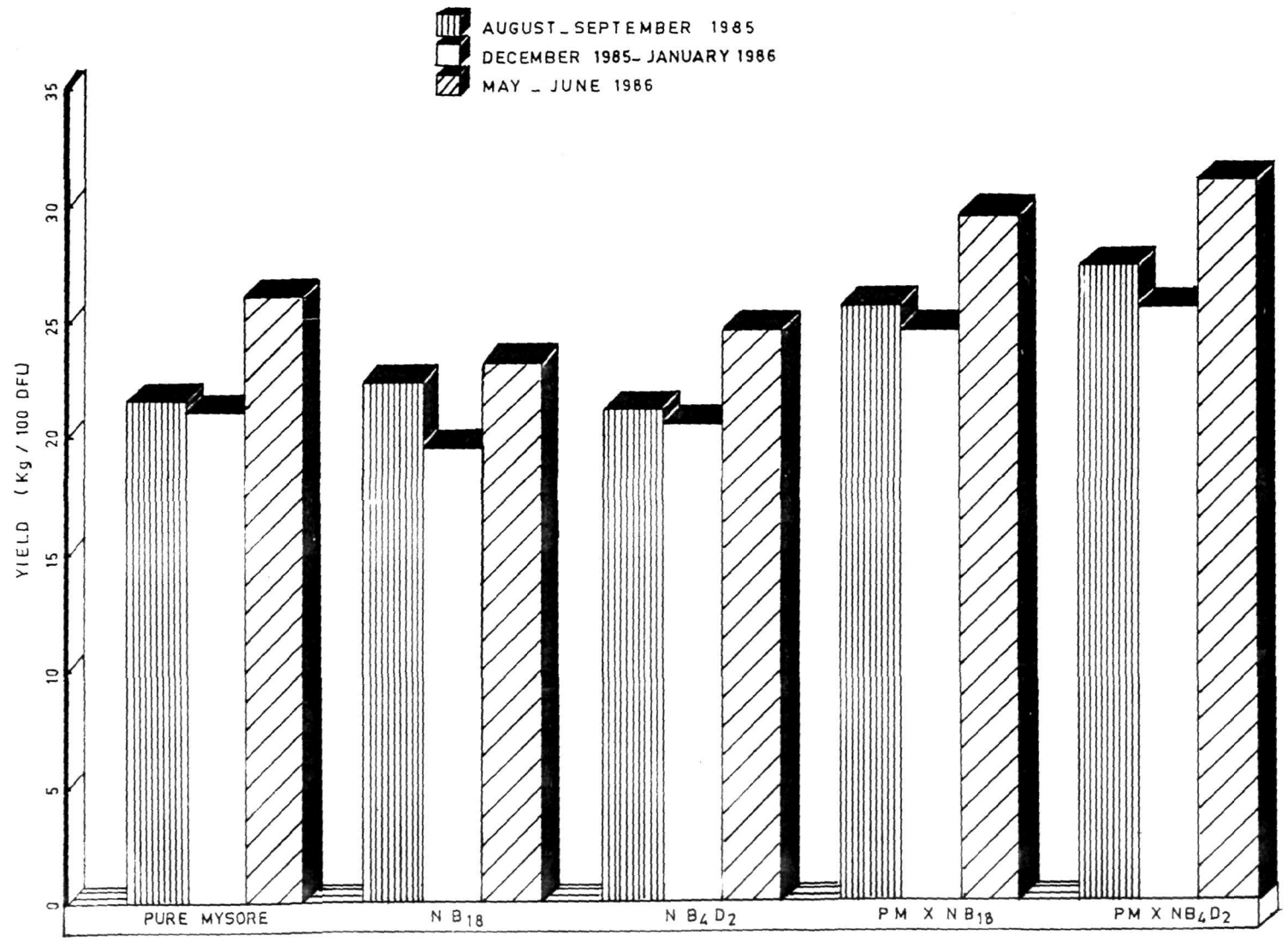

FIG. 4: COCOON YIELD OF THE MULBERRY SILKWORM RACES IN THE EASTERN DRY ZONE_KARNATAKA.
(UAS, BANGALORE)

Table 13. Cocoon yield performance of the silkworm races arranged in the order of productivity

Rearings	Performance				
	A	B	C	D	E
August-September 1985	PM X NB_4D_2	PM X NB_{18}	NB_{18}	PM	NB_4D_2
December 1985-January 1986	PM X NB_4D_2	PM X NB_{18}	PM	NB_4D_2	NB_{18}
May-June 1986	PM X NB_4D_2	PM X NB_{18}	PM	NB_4D_2	NB_{18}

It was 0.9590 g, 0.9310 g and 0.9377 g during August-September 1985, December 1985-January 1986 and May-June 1986, respectively (Table 14). The difference in cocoon weight was not significant among the cross breeds reared, but it was significantly higher than that of the Pure Mysore.

4.4.8 Shell weight

In all the three rearings the average shell weight was significantly high for NB_4D_2. It was 0.3372 g, 0.3302 g and 0.3385 g during August-September 1985, December 1985-January 1986 and May-June 1986, respectively. However, it was significantly low for Pure Mysore in all the three rearings, 0.1120 g, 0.1182 g and 0.1245 g during August-September 1985, December 1985-January 1986 and May-June 1986, respectively compared to the other races reared (Table 14).

4.4.9 Shell percentage

The shell percentage was significantly more in the case of NB_4D_2 during all the three seasons.

It was 18.84, 18.70 and 19.05 per cent for NB_4D_2, closely followed by NB_{18} with 18.29, 18.31 and 18.56 per cent during August-September 1985, December 1985-January 1986 and May-June 1986, respectively. However, the shell percentage was significantly lead for Pure Mysore with 12.71, 12.70 and 13.26 per cent during August-September 1985, December 1985-January 1986 and May-June 1986, respectively, compared to the other races reared (Table 14).

4.4.10 Pupal weight

In all the three rearings, NB_4D_2 recorded significantly higher pupal weight. It was 1.4407 g, 1.4270 g and 1.4350 g for August-September 1985, December 1985-January 1986 and May-June 1986 rearings, respectively. While the pupal weight was significantly low in the case of Pure Mysore with 0.8257 g, 0.8027 g and 0.8107 g during August-September 1985, December 1985-January 1986 and May-June 1986 rearings, respectively compared to the other races tried (Table 14).

4.4.11 Filament length

For all the three rearings, the individual reelable filament length was significantly high for NB_4D_2 with 751.75 m, 754.75 m and 768.50 m followed by NB_{18} with 733.45 m, 730.00 m and 744.25 m during August-September 1985, December 1985-January 1986 and May-June 1986 rearings, respectively (Table 14). On the other hand, the filament length was significantly minimum in the case of Pure Mysore with 413.00 m, 402.75 m and 425.00 m during August-September 1985, December 1985-January 1986 and May-June 1986, respectively.

4.4.12 Denier

The Denier was found to be significantly high in the case of NB_4D_2 during all the three rearings. It was 2.73, 2.69 and 2.80, closely followed by NB_{18} with 2.64, 2.62 and 2.72 during August-September 1985, December 1985-January 1986 and May-June 1986, respectively. However, the significantly low denier was found in Pure Mysore with 1.86, 1.79 and 1.97 during August-September 1985, December 1985-January 1986 and

May-June 1986 rearings, respectively compared to the other races reared (Table 14).

The mean values of each race in respect of qualitative parameters studied, were highly consistent between the crop rearings except in Pure Mysore (Table 14).

A slight decrease in pupal weight during August-September 1985 and December 1985-January 1986, PM X NB_4D_2 faired better than PM X NB_{18} in all the qualitative characteristics in all the three crop seasons studied. The former was on par with the pure bivoltines in respect of denier in August-September 1985 rearing.

NB_4D_2 was the best parent for various qualitative characteristics (Table 14) and Pure Mysore held the lowest position. The hybrids differed distinctly from each other in respect of cocoon yield in all the three rearings and PM X NB_4D_2 appeared to be the best multivoltine X bivoltine hybrid in the magnitude of various characteristics. PM X NB_{18} was the next best combiner indicating the more positive response of hybrid vigour.

Table 14. Performance of the selected races of silkworm B. mori L. in respect of economic parameters of silk cocoon during different rearings

Races	August - September 1985						December 85 - January 1986						May - June 1986					
	Cocoon weight (g)	Shell weight (g)	Pupal weight (g)	Shell percentage	Filament length (m)	Denier	Cocoon weight (g)	Shell weight (g)	Pupal weight (g)	Shell percentage	Filament length (m)	Denier	Cocoon weight (g)	Shell weight (g)	Pupal weight (g)	Shell percentage	Filament length (m)	Denier
Pure Mysore	0.9590^{d}	0.1220^{c}	0.8257^{d}	12.71^{d}	413.00^{c}	1.86^{c}	0.9310^{d}	0.1182,	0.8227^{d}	12.70^{d}	402.75^{c}	1.79^{c}	0.9377^{d}	0.1245^{d}	0.8107^{d}	13.26^{c}	425.00^{c}	1.97^{c}
NB_{18}	1.7035^{b}	0.3117^{b}	1.3617^{b}	18.29^{a}	733.75^{a}	2.64^{a}	1.6907^{b}	0.3097^{b}	1.3712^{b}	18.31^{a}	730.00^{a}	2.62^{a}	1.7045^{b}	0.3165^{b}	1.3930^{b}	18.56^{a}	744.25^{a}	2.72^{a}
NB_4D_2	1.7697^{a}	0.3372^{a}	1.4407^{a}	18.84^{a}	751.75^{a}	2.73^{a}	1.7657^{a}	0.3302^{a}	1.4290^{a}	18.70^{a}	754.75^{a}	2.69^{a}	1.7847^{a}	0.3385^{a}	1.4350^{a}	18.05^{a}	768.50^{a}	2.80^{a}
PM X NB_{18}	1.5890^{c}	0.2625^{d}	1.3600^{c}	16.51^{c}	670.50^{b}	2.48^{b}	1.5992^{c}	0.2645^{c}	1.3250^{c}	16.53^{c}	672.00^{b}	2.47^{b}	1.6027^{c}	0.2730^{c}	1.3235^{c}	16.99^{b}	678.50^{b}	2.49^{b}
PM X NB_4D_2	1.6072^{c}	0.2777^{c}	1.2945^{c}	17.28^{b}	685.00^{b}	2.52^{ab}	1.6010^{c}	0.2737^{c}	1.3185^{c}	17.10^{b}	681.25^{b}	2.52^{b}	1.6052^{c}	0.2788^{c}	1.3235^{c}	17.33^{b}	693.00^{b}	2.54^{b}
F-test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
C.D.(P=0.05)	0.0260	0.0134	0.0436	0.58	30.86	0.12	0.0232	0.0094	0.0171	0.39	31.69	0.08	0.0145	0.0093	0.0008	0.63	34.35	0.11

* Significant

Mean values superscribed with the same alphabet are not significantly different.

Table 15. Mean temperature and relative humidity inside the rearing room during all the three crop rearings (MRS, Hebbal)

Rearings	Mean temperature (°C)			Mean relative humidity (%)		
	Maximum	Minimum	Mean	7.20 a.m.	2.20 p.m.	Mean
August-September 1985	26.64	17.42	22.03	91.00	59.00	75.00
December 1985-January 1986	26.82	13.52	20.17	87.14	46.02	66.58
May-June 1986	32.24	21.15	26.70	66.37	41.29	53.83

DISCUSSION

V. DISCUSSION

In Karnataka, though different races or strains of mulberry silkworms are reared. It is needless to say the importance of the selection of silkworm race suited to a particular region and season for better yields. The current study deals with the evaluation of silkworm races in respect of effective rearing rate, cocoon yield and the related economic parameters of silk cocoon during different rearing periods.

The variation in cocoon yield among the races between seasons is multidimensional due to the interplay of many factors including management practices. The pure bivoltine race viz., NB_4D_2 followed by multi voltine X bivoltine cross breed viz., PM X NB_4D_2 were more popular with the industrial cocoon producers reared during rainy, post-rainy and summer months, respectively which obviously due to their capabilities, adaptability and productivity of the race and the hybrid (Siddappaji *et al*., 1983, 1987).

The results of the present study are discussed below according to the advantages of silkworm breeds (Anonymous, 1956, 1975).

5.1 Effective rate of rearing (ERR) in the selected races of mulberry silkworm

The effective rate of rearing was found to be maximum in Pure Mysore with 70.75 per cent during May-June 1986, as reported earlier where a maximum of 80.75 per cent of effective rate of rearing with Pure Mysore race during May-June 1967 (Anonymous, 1968). While it was high in the case of multivoltine X bivoltine cross breed PM X NB_4D_2 with 60.76 per cent during December 1985-January 1986 and 58.11 per cent during August-September 1985, respectively. This is in agreement with that of Kapila et al. (1983), they found that the effective rearing rate for multivoltine X bivoltine viz., PM X NB_{18} was high 91.52 and 95.16 per cent during June 1981 and July 1982, respectively. Among the pure bivoltines it was found maximum during May-June 1985 with 48.59 and 46.37 per cent in the case of NB_4D_2 and NB_{18}, respectively.

The difference in per cent survival (ERR) could be due to climatological variations coupled with management practices and place, which is attributable for the inherent capacities of the multivoltine crosses and interaction effect.

5.2 Matured larval weight

The average weight of normal ripened larva was significantly evident. The pure bivoltine viz., NB_4D_2 in all the three rearings was superior (3.4043, 3.4811 and 3.5316 g during August-September 1985, December 1985-January 1986 and May-June 1986 respectively) to NB_{18} followed by cross breeds viz., PM X NB_4D_2 and PM X NB_{18}. The steady increase in larval weight coincided with the increase in mean maximum temperature and decrease in relative humidity, respectively (Appendix IV, V and VI).

The difference in larval weight was 1.7909, 1.8549 and 1.8140 g during August-September 1985, December 1985-January 1986 and May-June 1986, respectively as expected of the multivoltine race.

The present findings are in conformity with that of Jolly et al. (1982), who reported that the larval weight was maximum in the case of Pure Mysore (1.80 g) compared to pure bivoltines and cross breeds, irrespective of the season.

Here again though the larval weight in multivoltine race was low compared to that of bivoltine race, the trend of variation with respect to larval weight was remained almost similar, which is attributable to the inherent characteristics of the silkworm races.

5.3 Larval duration

The larval duration was significantly low and superior in the case of cross breed viz., PM X NB_4D_2 in all the experimental rearings (27.34, 28.24 and 26.67 days during August-September 1985, December 1985-January 1986 and May-June 1986, respectively) except during August-September 1986, it was on par with PM X NB_{18}. The duration of larvae was significantly high and inferior in the case of Pure Mysore race with 29.58, 30.41 and 28.62 days in all the three

rearings respectively. This is in agreement with that of Krishnaswamy et al. (1971) who found that the highest larval duration of 30.17 days:hours in the case of Pure Mysore compared to that of other races, irrespective of the seasons.

In all the races the reason for long larval duration during December 1985-January 1986 may be due to usual low mean temperature (13.52°C) (Table 15). Another interesting feature was that the length of variation in larval duration between multivoltines and bivoltine race studied was 2.24, 2.17 and 1.95 days during August-September 1985, December 1985-January 1986 and May-June 1986, respectively indicating the effect of seasons on growth of mulberry silkworm irrespective of the races.

5.4 Per cent crop loss

In all the three experimental rearings, the crop loss was mainly due to diseases and pests particularly the Indian Uji fly. The combined loss ranged from 29.58 to 45.63 per cent during August-

September 1985, 26.32 to 53.22 per cent during December 1985-January 1986 and 23.14 to 45.67 per cent during May-June 1986.

In the first rearing the crop loss was maximum in the case of NB_4D_2 and minimum in PM X NB_{18} of all the diseases grasserie followed by kenchu dominated the scene. While in second and third rearing, the mortality of silkworms at 5th instar due to Uzi fly infestation, ranged from 10.77 to 12.33 and 8.38 to 11.72 per cent, respectively. At 5th instar the local multivoltine race viz., Pure Mysore was found to be preferred by the Indian Uzi fly compared to other races and strains studied, in both the rearings. The results are in close confirmity with the findings of Siddappaji (1985) and Padmanabha Bhatt (1986), who recorded the highest (26.0) number of parasitized worms in Pure Mysore and the lowest in C.nichi (12.75) per one laying.

In the second rearing the incidence of white muscardine (Beauvaria bassiana), was observed to be high followed by grasserie and flacherie in all the races but quite high in bivoltine races tried.

5.5 Cocoon yield

The projected cocoon yield was found to be high in the case of multivoltine X bivoltine (cross breed) viz., PM X NB_4D_2 in all the three experimental rearings (27.166, 25.533 and 31.000 kg during August-September 1985, December 1985-January 1986 and May-June 1986, respectively) and superior to PM X NB_{18}. The former race out yield the latter with the per cent additional gain of 7.6, 5.2 and 5.4 per cent during August-September 1985, December 1985-January 1986 and May-June 1986, respectively. Among the bivoltines, NB_4D_2 faired better with the yield of 21.066, 20.433 and 24.660 kg cocoons and NB_{18} yielded 22.100, 19.400 and 23.030 kg during the three experimental rearings, respectively and the yield performance was quite better during May-June 1986 compared to other rearings. The multivoltine race also performed better during May-June 1986 with the yield of 26.000 kg compared to other rearings. The Pure Mysore faired better compared to bivoltines tried during December 1985-January 1986 and May-June 1986 but during August-September 1985, it is next only to NB_{18} and superior to NB_4D_2 (Table 12). The above findings are in agreement with those

of Tayade (1983) who found the maximum cocoon yields during May-June-July 1979 with 29.70 kg in Wa7-4 (multivoltine), 36.5 kg for KA (bivoltine) and 46.5 kg for PM X KA (multivoltine X bivoltine) per 100 layings. But these results are contrary to that of Chandrashekar (1981), who found maximum average cocoon yield of 37.90 kg during January-February 1981 and minimum average yield of 12.00 kg during June 1980 per 100 layings in the case of cross breeds viz., PM X NB_4D_2, PM X KA. According to Siddappaji et al. (1983, 1987) the variation in seasonal condition had very little influence on cocoon yields of multivoltine X bivoltine hybrids especially with PM X NB_4D_2 and PM X NB_{18} in summer rearings. The cocoon yield among the bivoltines was comparatively high during summer rearings, thus indicating the influence of the season and the common trend.

The probable reason for low yield in first two rearings could be due to high mortality of silkworms after IV moult due to incidence of diseases and Ugi fly infestation, and fall in temperature and raise in humidity (Appendix IV, V & VI). The cross

breeds faired better compared to bivoltines and multivoltine tried may be due to better resistance to poor environment and to inclement weather conditions indicating wider adoptability to varying climatological conditions between seasons. The results also demonstrated that both NB_4D_2 and NB_{18} possess excellent combining ability with Pure Mysore as female parent for exhibiting hybrid vigour. The former cross breed viz., PM X NB_4D_2 yielded better even under stress situations closely followed by PM X NB_{18}, which could be the main reason for their main stay of the cross breeds with the sericulturists in the traditional sericultural area and PM X NB_4D_2 being the ruling race as reported by Siddappaji *et al.* (1987).

5.6 Number to weight of cocoons

The number of normal cocoons per unit weight of 100 g in the case of Pure bivoltines viz., NB_4D_2 and NB_{18} was found to be significantly low and superior to that of cross breeds and Pure Mysore, which indicated the inherent probabilities irrespective of the season. It was 69, 68 and 67 cocoons for

NB_4D_2 and 71, 73 and 70 cocoons for NB_{18} during August-September 1985, December 1985-January 1986 and May-June 1986, respectively. The data were highly consistent and fall in line with the findings of Mariswamy et al. (1982), they found minimum number of cocoons per kg weight in the case of NB_{18} and NB_4D_2 with 606 and 660 cocoons, respectively during May-June 1981.

The number of cocoons per unit weight of 100 g was significantly high and inferior in the case of Pure Mysore with 109, 108 and 108 cocoons during the three experimental rearings, respectively. The variation may be mostly due to the climatological variations between the seasons. The data also indicated that the variation in number to weight of silk cocoons per unit weight, among the races and between the experimental rearings representing different crop seasons was least evident for the particular cocoon character, which is not in agreement with the findings of Tayade (1983), who found 817 and 1125 cocoons/kg weight in Wai-4 multivoltine race during July-August and August-September 1978, respectively. The variation between season attributable for the drastic fluctuation in the weather conditions in that place.

5.7 Cocoon weight

The difference in the average weight of normal cocoon was significantly high (1.7847, 1.765₹ and 1.7847 g during August-September 1985, December 1985-January 1986 and May-June 1986, respectively) for NB_4D_2 in all three experimental rearings, indicating its superiority over NB_{18}. While the latter was superior to cross breeds and Pure Mysore. However, all the improved breeds tried were significantly superior to Pure Mysore race. These findings are in agreement with the findings of Pillai and Raju (1982) who found the range in cocoon weight was 1.538 to 1.954 g in the case of Pure bivoltines which was more or less line with the present findings. Similarly, Jolly et al. (1985) found that the minimum cocoon weight of 0.903 g in Pure Mysore compared to bivoltines and crossbreeds, irrespective of the seasons.

The increase in cocoon weight in pure bivoltines and reduction in multivoltines are attributable to the racial characteristics. Here again the variation in average weight of cocoons between the seasons

was insignificant indicating the wider adaptability. This race was able to produce what it can and perform well.

5.8 Shell weight

The difference in the average shell weight was significantly evident. The pure bivoltine viz., NB_4D_2 (0.03372, 0.3302 and 0.3385 g) in all the three rearings was superior to NB_{18}. The latter was superior to cross breeds and pure Mysore. Among the cross breeds, PM X NB_4D_2 was significantly superior to PM X NB_{18} during August-September 1985, but on par during rest of the rearings. Pure Mysore was inferior to all other races tried, as expected of multivoltine race.

Though the range of variation between the seasons was not clearly evident the average shell weight was low during the December 1985-January 1986 rearing which is probably due to fall in minimum temperature (13.52°C) (Appendix, IV, V & VI).

5.9 Pupal weight

The difference in average weight of pupa was significant and it was high in the case NB_4D_2 in all three experimental rearings. It was 1.4407, 1,4270 and 1.4350 g during August-September 1985, December 1985-January 1986 and May-June 1986, respectively and superior to NB_{18} followed by cross breeds and Pure Mysore, while the difference among the cross breeds was not significant they were on par with each other, but superior to Pure Mysore race.

The increased pupal weight of the pure bivoltines have also resulted in decrease in the number of cocoons per unit weight correspondingly, contributing towards the superiority of the bivoltine strains. However, increase in pupal weight in pure bivoltines and reduction in multivoltines are attributable to the racial characteristic.

5.10 Shell percentage

The average shell percentage was found to be significantly high in the case of pure bivoltines

viz., NB_4D_2 and NB_{18} (18.84, 18.70 and 19.05 per cent for NB_4D_2 and 18.29 , 18.31 and 18.56 per cent, during August-September 1985, December 1985-January 1986 and May-June 1986, respectively) in all the three experimental rearings and superior to PM X NB_4D_2 and PM X NB_{18}. The difference in the latter was significant during August-September 1985 and December 1985-January 1986, but on par during May-June 1986. These findings are in agreement with the earlier report (Anonymous, 1982b) where they found that the higher shell percentage of 19.52 and 18.75 per cent in the case of NB_{18} and NB_4D_2 during June 1982 compared to that of the January 1983 rearing. According to Krishnaswamy et al. (1971), who found the shell per cent of 10.27 in the case of Pure Mysore.

Among the cross breeds PM X NB_4D_2 faired better in all the three rearings compared to PM X NB_{18}. The shell percentage recovered was high for both the bivoltine races during May-June 1986 and similar trend was noticee in other races tried.

This may be attributable to the climatological variations among the seasons.

5.11 Filament length

In all the three experimental rearings the length of the reelable filament was significantly high in the case of Pure bivoltines. It was 751.75, 754.75 and 768.00 m for NB D and 733.45, 730.00 and 744.25 m for NB_{18} during August-September 1985, December 1985-January 1986 and May-June 1986, respectively and superior to PM X NB_4D_2 and PM X NB_{18}. The cross breeds tried were on par with each other, but superior to Pure Mysore race.

The significant increase in reelable filament in pure bivoltines and reduction in multivoltines is obviously due to the inherent capacities of the races. A steady increasing trend in length of the reelable filament was noticeable in the case of NB_4D_2 and it was maximum during May-June 1986, while it was considerable low during December 1985-

January 1986 for other races also, which is probably due to fall in minimum temperature (13.52°C), (Appendix IV, V & VI).

5.12 Denier

The deviation in denier was found to be significantly superior in the case of pure bivoltines viz., NB_4D_2 and NB_{18}. It was 2.73, 2.69 and 2.80 for NB_4D_2 and 2.64, 2.62 and 2.72 for NB_{18} during August-September 1985, December 1985-January 1986 and May-June 1986, respectively. It was on par with NB_{18} and PM X NB_4D_2 during August-September 1985 and the latter was inferior during the other rearings. The denier deviation was not significant among the cross breeds in any of the seasons, but superior to Pure Mysore. The reason for denier deviations in different silkworm races are attributable mainly to the racial characteristics. Such detailed and related studied were neglected in the early works.

Though the cocoon characteristics and the related qualitative parameters appeared to be good

and in some significantly the best, in favour of bivoltines viz., NB_4D_2 followed by NB_{18}, the ERR/survival, larval duration, and cocoon yield were found to be better in the case of multivoltines X bivoltines viz., PM X NB_4D_2 followed by PM X NB_{18}, compared to pure bivoltines and multivoltine race tried.

Among the cross breeds PM X NB_4D_2 followed PM X NB_{18} which stood the stress situation and performed excellently in respect of cocoon productivity in all the three seasons tried, compared to pure bivoltines and multivoltine race. The probable reason for high performance of the multivoltine X bivoltines consistently during different crop seasons is obviously due to hybrid vigour coupled with their built-in mechanism for resisting the poor environment.

The multivoltine race viz., Pure Mysore (PM) performed better than the pure bivoltine races tried, but inferior to that of the hybrid combinations. The latter excelled both the parents. The Pure Mysore race maintained the third place in both

December 1985-January 1986 and May-June 1986, next only to the cross breeds and fourth place during August-September 1985. The probable reason for this superiority over pure bivoltines could be the acclamatization of the local land race and its inherent capacity to resist poor environment. However, the pure bivoltine viz., NB_{18} was third in respect of cocoon yield, next only to the cross breeds during August-September 1985. Both the bivoltine races tried, could not yield better than the other races tried and retained the fifth place in all the three crops (Table 12 & 13), which is attributable for their high susceptibility to inclement weather (Table 15) particularly high temperature and low relative humidity and diseases as compared to multivoltine X bivoltine cross breeds.

The data is suggestive that introduction of new bivoltine races has helped the development of very good combinations between multivoltines and bivoltines which match the stress situations/poor environment. During rainy and post-rainy months, the pure bivoltines may be exploited for improvement on the quality and to achieve the economic prosperity in the Eastern Dry Zone of Karnataka.

The success of the newer cross breeds, especially PM X NB_4D_2 followed by PM X NB_{18} in the three crops reared was dependent on their ability to surpass the performance of either of the parents (multivoltine as female and bivoltine as male) or to offer a broader spectrum of biological response under ordinary conditions of rearing and the productivity was independent of the climatological variations. There is no doubt that with each new introduction the criteria for commercial success will become more stringent and in the instant case NB_4D_2 has been found as a good base for hybridization programme on improving the quality standards, while PM X NB_4D_2 was able to nick well and match NB_4D_2 in respect of cocoon characteristics, much better than PM X NB_{18}.

It is hoped that this study will induce further work in this interesting area in many centres of the varied agro-climatic zones of Karnataka and make this crop industry more viable.

SUMMARY

VI. SUMMARY

The present investigation aiming at evaluation of popular races of Bombyx mori L. in respect of cocoon productivity and major economic parameters during the experimental rearings for the benefit of the industrial cocoon producers in the Eastern Dry Zone of Karnataka are summarised.

The experiments were conducted with the more popular races of mulberry silkworms viz., Pure Mysore (multivoltine), NB_{18}, NB_4D_2 (bivoltine), PM X NB_{18} and PM X NB_4D_2 (multivoltine X bivoltine) were reared under normal conditions at Main Research Station of the University of Agricultural Sciences, Bangalore during August-September 1985, December 1985-January 1986 and May-June 1986.

In two of the three experiments, the effective rate of rearing was maximum in the case of cross breed viz., PM X NB_4D_2 (58.11 and 60.76 per cent) during August-September 1985 and December 1985-January 1986, respectively, while during May-June 1986 it was maximum

in the case of Pure Mysore (70.75 per cent), while the larval duration was also minimum in the case of PM X NB_4D_2 (27.34, 28.24 and 26.67 days) followed by PM X NB_{18} (27.54, 28.95 and 27.21 days) during August-September 1985, December 1985-January 1986 and May-June 1986 rearings, respectively.

The overall cocoon productivity was better for the cross breeds viz., PM X NB_4D_2, followed by PM X NB_{18} compared to pure bivoltines and multivoltine races tried in all the three rearings. The maximum cocoon yield was 31.00 kg for PM X NB_4D_2 and 29.83 kg for PM X NB_{18} per 100 layings during May-June 1986.

The performance of all the races was at their best during May-June 1986 for Pure Mysore, NB_{18}, NB_4D_2, PM X NB_{18} and PM X NB_4D_2 with the cocoon yield of 26.00 kg, 23.03 kg, 24.66 kg, 29.33 and 31.00 kg per 100 layings, respectively. However, the cocoon yielding capacity per 100 layings was found to be

low during December 1985-January 1986 with 21.00 kg for Pure Mysore, 19.4 kg for NB_{18}, 20.43 kg for NB_4D_2, 24.33 kg for PM X NB_{18} and 25.53 kg for PM X NB_4D_2. The study indicated that the multivoltine X bivoltine (cross breeds) faired better indicating their inherent capacities to resist the poor environment (low temperature and low humidity) and match the situations better under commercial cocoon producers level.

The cocoon crop loss was more due to the incidence of diseases viz., grasserie, flacherie, muscardine and the Indian Uji fly infestation during December 1985-January 1986 and August-September 1985, while it was low during May-June 1986 rearing.

The qualitative cocoon characteristics like the average, weight of cocoon, shell and pupa, and shell percentage, reelable filament length and denier, were excellent in the case of pure bivoltines viz., NB_4D_2, followed by NB_{18} indicating the all-round improvement on silk quality. The difference in the cocoon characteristics was significantly high during May-June 1986 rearing indicating the superiority to

that of other races and crop seasons. The high productivity was influenced by low temperature and high humidity prevailed among rearing months (May-June 1986). Rearing of cross breeds (multivoltine X bivoltines) was always found to be more economical and suitable for all the seasons and match the situations of the industrial cocoon producers due to the inherent capabilities, adaptability, productivity and resistant to poor environment by the hybrid races.

The hybrid combination of the multivoltine X bivoltine parents surpassed both the parents in the magnitude of quantitative characteristics viz., egg hatchability, effective rate of rearing, cocoon yield, indicating the positive heterotic response.

The study indicated the need and scope for further improvement in the area of silkworm breeds as suited to different agro-climatic situations is sure to follow.

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APPENDICES

Appendix I: Case sheet of the first rearing (August-September 1985)

Location	-	Main Research Station, University of Agricultural Sciences, Bangalore				
Silkworm race	-	Pure Mysore	NB_{18}	NB_4D_2	PM X NB_{18}	PM X NB_{18}
Number of layings	-	15	15	15	15	15
Source of eggs	-	Government Silk-worm Bilidevalaya	Government Grainage, National Silkworm Seed Project Bangalore.			
Cost of eggs/100 layings	-	Rs.20.00	Rs.20.00	Rs.20.00	Rs.60.00	Rs.60.00
Silkworm brushed on	-	12.8.85	12.8.85	12.8.85	11.8.85	11.8.85
Cocoon harvested on	-	16.9.85	15.9.85	15.9.85	13.9.85	13.9.85
Cocoon yield	-	3.220 kg	3.315 kg	3.160 kg	3.835 kg	4.075 kg

Appendix II: Case sheet of the second rearing (December 1985-January 1986)

Location	-	Main Research Station, University of Agricultural Sciences, Bangalore				
Silkworm race	-	Pure Mysore	NB_{18}	NB_4D_2	PM X NB_{18}	PM X NB_4D_2
Number of layings	-	15	15	15	15	15
Source of eggs	-	Government Silk Farm, Bilidevalaya	Government Grainage, National Silkworm Seed Project, Bangalore.			
Cost of eggs/100 layings	-	Rs.20.00	Rs 20.00	Rs 20.00	Rs 60.00	Rs.60.00
Silkworm brushed on	-	10.12.1985	11.12.1985	11.12.1985	10.12.1985	10.12.1985
Cocoon harvested on	-	15.1.1986	15.1.1986	15.1.1986	13.1.1986	13.1.1986
Cocoon yield	-	3.150 kg	2.910 kg	3.065 kg	3.650 kg	3,830 kg

Appendix III: Case sheet of the third rearing (May-June 1986)

Location	-	Main Research Station, University of Agricultural Sciences, Bangalore				
Silkworm race	-	Pure Mysore	NB_{18}	NB_4D_2	PM X NB_{18}	PM X NB_4D_2
Number of layings	-	15	15	15	15	15
Source of eggs	-	Government Silk Farm, Bilidevalaya.	Government Grainage, National Silkworm Seed Project, Bangalore.			
Cost of eggs/100 layings	-	₹ 20.00	₹ 20.00	₹ 20.00	₹ 60.00	₹ 60.00
Silkworm ants brushed on	-	5.5.1986	6.5.1986	6.5.1986	7.5.1986	7.5.1986
Cocoon harvested on	-	8.6.1986	8.6.1986	8.6.1986	8.6.1986	8.6.1986
Cocoon yield	-	3.900 kg	3.460 kg	3.700 kg	4.400 kg	4.650 kg

Appendix IV: Temperature and relative humidity recorded during August-September 1985

Date	Temperature °C		Relative humidity (%)	
	Maximum	Minimum	7.20 a.m.	2.20 p.m.
10.8.85	24.4	17.1	94	58
11.8.85	25.5	17.5	93	57
12.8.85	28.6	17.5	88	59
13.8.85	25.6	17.4	95	63
14.8.85	26.0	17.7	94	62
15.8.85	27.4	18.0	94	62
16.8.85	27.0	17.5	93	57
17.8.85	27.5	17.0	96	53
18.8.85	28.0	17.0	88	62
19.8.85	25.5	17.1	93	56
20.8.85	26.5	17.7	84	50
21.8.85	27.5	16.9	95	53
22.8.85	26.5	17.1	88	57
23.8.85	28.0	18.2	86	48
24.8.85	27.0	17.3	78	55
25.8.85	26.6	17.2	88	60
26.8.85	28.5	18.0	91	59
27.8.85	26.6	17.7	87	60
28.8.85	25.0	16.9	86	58
29.8.85	26.0	17.0	84	60
30.8.85	27.1	17.2	86	56
31.8.85	26.7	17.9	86	56
1.9.85	28.5	19.0	92	52
2.9.85	27.5	17.2	93	60
3.9.85	26.5	17,0	93	54
4.9.85	25.0	17.2	91	55
5.9.85	26.0	17.4	94	60
6.9.85	27.2	17.5	94	61
7.9.85	26.0	17.1	96	60
8.9.85	26.5	17.2	93	65
9.9.85	27.5	17.8	95	70
10.9.85	26.9	16.9	93	65
11.9.85	27.5	17.5	98	81
12.9.85	26.5	17.0	93	59
13.9.85	28.5	18.0	93	60
Mean	26.64	17.42	91.0	59.0

Appendix V: Temperature and relativehumidity recorded during December 1985 and January 1986

Date	Temperature °C		Relative humidity (%)	
	Maximum	Minimum	7.20 a.m.	2.20 p.m.
3.12.85	24.6	10.0	86	44
4.12.85	25.9	13.8	94	60
5.12.85	24.9	11.9	89	59
6.12.85	25.8	18.6	80	31
7.12.85	26.8	16.8	90	44
8.12.85	27.4	12.0	95	61
9.12.85	27.3	13.0	82	45
10.12.85	27.4	10.0	96	52
11.12.85	28.0	11.1	98	47
12.12.85	27.6	14.5	94	38
13.12.85	27.8	15.0	88	32
14.12.85	27.9	15.4	88	32
15.12.85	25.9	14.0	98	42
16.12.85	26.9	14.9	98	49
17.12.85	25.9	16.6	87	49
18.12.85	25.9	16.6	87	44
19.12.85	26.0	12.1	85	61
20.12.85	27.4	14.1	87	63
21.12.85	26.4	14.5	88	43
22.12.85	28.9	13.6	78	34
23.12.85	27.6	14.5	92	32
24.12.85	27.9	13.3	93	36
25.12.85	26.6	13.8	79	41
26.12.85	26.6	14.1	96	50
27.12.85	26.4	13.8	83	45
28.12.85	26.4	14.0	88	37
29.12.85	26.4	16.0	83	44
30.12.85	28.3	15.0	85	45
31.12.85	28.2	14.5	84	43
1.1.86	28.6	14.9	96	50
2.1.86	28.8	12.0	96	55
3.1.86	28.3	11.9	80	60
4.1.86	27.4	12.0	94	49
5.1.86	26.4	14.5	93	56
6.1.86	26.9	12.5	93	52
7.1.86	27.4	13.0	83	60
8.1.86	26.3	14.0	94	46
9.1.86	26.9	13.2	75	41
10.1.86	25.9	12.6	92	45
11.1.86	26.0	13.6	94	37
12.1.86	25.9	12.5	94	51
13.1.86	26.4	13.5	96	54
14.1.86	25.3	11.2	86	43
Mean	26.82	13.52	87.14	46.02

Appendix VI: Temperature and relative humidity recorded during May-June 1986

Date	Temperature (°C)		Relative humidity (%)	
	Maximum	Minimum	7.20 am.	2.20 pm.
3.5.86	34.3	21.2	68	37
4.5.86	34.5	22.4	68	55
5.5.86	31.5	20.9	66	39
6.5.86	30.7	21.2	63	42
7.5.86	33.0	22.1	61	39
8.5.86	32.5	21.1	71	50
9.5.86	33.0	22.5	71	49
10.5.86	34.3	24.1	68	42
11.5.86	31.0	20.7	63	42
12.5.86	32.5	21.6	61	38
13.5.86	30.7	20.1	67	46
14.5.86	33.7	21.7	71	44
15.5.86	33.8	22.5	70	38
16.5.86	32.2	21.1	63	38
17.5.86	32.0	17.8	66	39
18.5.86	30.5	19.8	65	40
19.5.86	33.2	22.6	63	37
20.5.86	30.5	21.1	62	42
21.5.86	32.4	20.8	62	39
22.5.86	33.1	21.3	64	44
23.5.86	34.3	22.8	75	42
24.5.86	31.3	19.8	68	39
25.5.86	33.7	20.4	64	43
26.5.86	32.8	19.9	63	42
27.5.86	30.7	19.9	62	39
28.5.86	32.2	22.0	64	46
29.5.86	32.0	21.3	71	44
30.5.86	30.3	20.1	70	39
31.5.86	31.0	19.4	63	44
1.6.86	30.0	20.1	60	38
2.6.86	33.0	22.1	70	38
3.6.86	34.3	20.4	61	42
4.6.86	32.0	21.1	66	41
5.6.86	33.8	22.3	75	43
6.6.86	32.8	20.4	72	38
7.6.86	30.0	20.1	71	44
8.6.86	29.3	19.4	68	42
9.6.86	30.8	20.0	66	39
Mean	32.24	21.15	66.37	41.29