Androgenesis, though an accepted breeding tool for the development of homzygous plants (Naleczynska, 1991; Datta, 2005) and animals (Parsons and Thorgaard, 1985; Komma and Endow, 1995), this technique, so far has not been used for the development of superior multivoltine silkworm breeds and multivoltine × bivoltine hybrids which contribute more than ninety percent of the silk production in India (Datta and Chatterjee, 1991; Datta et al., 2001).

In the mulberry silkworm, *Bombyx mori*, androgenesis may serve as an important breeding strategy for the development of bisexual homzygous multivoltine silkworm breeds which are of immense use in silkworm breeding in order to obtain high hybrid vigour. Bisexual homzygous androgenetic lines have been developed through the application of androgenesis (Malinova et al., 1996; Xu et al., 1997; Nacheva et al., 1999). Androgenesis acquires special significance in silkworm breeding for the development of homzygous lines with excellent combining ability, high hybrid vigour, high viability and less phenotypic variability (Strunnikov et al., 1982). In androgenetic development, the embryo develops at the expense of cytoplasm of the mother egg cell and the male nuclear material (Astaurov, 1967). Androgenesis in silkworm is one of the completely sex control theory to breed isogenic male offsprings (Xu et al., 2004).

Induction of androgenetic development in silkworm, *B mori*, L has been carried out by various inducing agents like X-ray (Astaurov, 1957; Strunnikov, 1975), gamma rays (Xu et al., 1988; 1997), CO$_2$ and dry ice (Tazima and Onuma, 1967; Li et
al., 1988), high temperature (Strunnikov, 1983; 1987) and low temperature (Sugai et al., 1987). The present study was undertaken to develop superior silkworm breeds through induction of androgenesis coupled with conventional breeding technique with the main objective to possess shorter larval span, high viability, hybrid vigour, combining ability and comparatively uniform cocoons. Several androgenetic larvae in F1 hybrids between multivoltine and bivoltine breeds by subjecting the eggs to hot air 40°C for 135 min have been obtained (Ravindra Singh et al., 1991).

In the present study, induction of androgenetic development was pronounced by exposing the eggs at 38°C for 200 min as compared to treatment of eggs at 40°C for 135 min and 42 °C for 210 min. (Nirupama and Ravindra Singh, 2007a). The androgenetic individuals were obtained by utilising multivoltine race Nistari as genetic marker and crossed with BL₆₈ × BL₆₀ F₂ hybrid male.

Homoygous males have been obtained in silkworm by several workers (Tazima, 1964; Astaurov, 1967; Strunnikov, 1975; Chowdhary, 1989; Ravindra Singh et al., 2001a). Androgenesis provides opportunities for the production of homozygous bisexual lines and it may become a valuable tool in silkworm breeding (Xu et al., 1997; Nacheva et al., 1998). The advantage of androgenesis over conventional breeding method is that within short period of time, a new line would be produced and development of outstanding genotypes with less phenotypic variability, exhibiting more hybrid vigour and combining ability (Ravindra Singh et al., 2004). It can prove to be an important tool in silkworm breeding as maximum hybrid vigour is obtained from F₁ hybrid between homozygous lines Nacheva et al., 1999). As estimated by Huang (1980), 10 to 15 % more silk can be produced by rearing only male silkworms.
Androgenetic individuals obtained from this method were used as donor for transmission of their homozygosity into promising ordinary lines by series of backcrosses. The possibility of developing superior silkworm breeds through application of androgenesis has been explored (Strunnikov, 1982; Malinova et al., 1996; Xu et al., 1997; Nacheva et al., 1999). Five multivoltine androgenetic lines namely, AGL1, AGL2, AGL3, AGL4 and AGL5 have been established.

In India, breeding of silkworm since long been aimed towards the development of superior silkworm breeds to get stabilized crops and to improve both quality and quantity of silk (Tazima, 1984). Breeding plays a pivotal role in improving the productivity of silkworm breeds for commercial utilization. Bulk of the silk produced in India is either from multivoltine or multivoltine × bivoltine hybrids (Datta, 1984; Datta et al., 2001).

Systematic evaluation is one of the most important aspects in silkworm breeding to identify superior breeds and hybrids. Success of breeding largely depends upon choice of promising parents. Evaluation of superior silkworm breeds and hybrids plays a decisive role in the identification of potential parents in order to derive productive hybrids for commercial exploitation (Yokoyama, 1957). Efforts have been made to verify the developed silkworm breeds and hybrids through multiple trait evaluation index method (Mano et al., 1993) and subordinate function index method (Gower, 1971) for eleven economic characters. Data were analyzed to assess and judge their superiority of promising silkworm breeds and hybrids. Evaluation of desirable breeds impartially on the basis of cumulative effect of several characters is important (Narayanaswamy et al., 2002; Singh, 2001). Evaluation index method has
been used to identify multivoltine breeds (Kariappa and Rajan, 2005; Nazia Choudhary and Ravindra Singh, 2006c) and bivoltine silkworm breeds/hybrids (Rajalakshmi et al., 2000; Rao et al., 2001b; Ramesh Babu et al., 2002).

Results of the present study revealed that among multivoltine breeds AGL₃ (53.90 %) and AGL₅ (63.80 %) were identified as better parents based on average multiple trait evaluation index value. AGL₃ showed its superiority for eight characters except cocoon yield /10,000 larvae by weight, cocoon weight and cocoon shell weight. AGL₅ exhibited its excellence for all the economic characters namely, fecundity, hatching, pupation rate, cocoon yield /10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length, reelability, raw silk and neatness. Identification of breeds/ hybrids depends not only on synthesis of genotype but also under the influence of environmental condition (Rahman and Ahmed, 1988). As per the sub-ordinate function index value, AGL₅ has shown higher cumulative index values (10.95) followed by AGL₃ (7.45). AGL₅ and AGL₃ indicated their importance for nine and four economic characters, respectively. Evaluation index method has been extensively used by many breeders and identification of superior breeds/ hybrids for commercial purpose ((Narayanswamy et al., 2002; Ramesh Babu et al., 2002; Kariappa and Rajan, 2005; Nazia Choudhary and Ravindra Singh, 2006c).

In the present study, data of thirty multivoltine × bivoltine hybrids were analyzed. Out of thirty, two hybrids AGL₃ × CSR₂ (65.25) and AGL₅ × CSR₂ (68.52) exhibited high average evaluation index values and excelled their superiority for all the important characters. Maximum subordinate cumulative indices of 10.40 and 9.70 were observed in AGL₅ × CSR₂ and AGL₃ × CSR₂ respectively over the control PM ×
Extensive studies have been made on evaluation of multivoltine × bivoltine hybrids (Ravindra Singh et al., 1998a; 2001a; Mal Reddy et al., 2002; Rao et al., 2003; Dandin et al., 2007; Nirupama and Ravindra Singh, 2007b; Rao et al., 2007). The present results clearly showed that AGL5 × CSR2 and AGL3 × CSR2 were found promising exhibiting their superiority especially for cocoon yield / 10,000 larvae by weight, cocoon weight, cocoon shell weight and reelability. The results are in agreement with that of Krishnaswami and Narasimhana (1974), Das et al. (1995) Kalpana and Reddy (1998), Ravindra Singh et al. (2004). Selection methods lead to majority of economic characters that contribute to the improved cocoon yield (Rao et al., 2002). Evaluation of quantitative and qualitative characters by both the statistical methods of multiple traits evaluation index and subordinate function index, two breeds AGL3 and AGL5 and two hybrids AGL3 × CSR2 and AGL5 × CSR2 that ranked first and second, were identified as promising silkworm breeds and hybrids. Recently, studies have been made on bivoltine hybrids (Rohith et al., 2007; Murthy and Subramanya, 2007) and multivoltine × bivoltine hybrids (Sudha et al., 2007).

It is necessary to adopt reliable statistical methods for identification of promising breeds and hybrids giving weightage to all the economic characters. Attempts have been made to identify promising silkworm hybrids utilizing multiple traits evaluation index method and subordinate function index method simultaneously (Ramesh Babu et al., 2002; Rao et al., 2001b; 2004; Lakshmi and Chandrashekhariah, 2007).

Analysis of variance for combining ability was estimated for thirteen important characters. Analysis of combining ability is a widely used biometrical tool to select promising parents and hybrids (Falconer and Mackay, 1996) to detect the
genetic variability in organism (Arunachalam, 1994) and to increase heterotic effects for quantitative characters (Ohkuma, 1971; Strunnikov 1986; Tayade, 1987). In the present study, a great deal of variation was observed. Among treatments and crosses highly significant variations were observed. Parents (lines), parent (line vs. tester) and parents vs. crosses were highly significant for twelve out of thirteen characters. This may be due to presence of sufficient variability among the genotypes. Selection of suitable parents and information on gene action are important for crop improvement (Kumar and Kang, 2001). Extensive studies have been carried out on combining ability in silkworm, *B. mori* (Bhargava et al., 1995; Rajalakshmi et al., 1997; Rao et al 1998; Ravindra Singh et al., 2000; 2003). Recently, studies have been made on heterosis and combining ability in multivoltine × bivoltine hybrids (Nazia Choudhary and Ravindra Singh, 2006b; Sofi et al., 2008).

Percent contribution of lines, testers and line × tester analysis was determined for thirteen characters. Percent contribution of lines was found maximum for total larval span (81.75 %) followed by fecundity (58.33 %), raw silk percentage (52.57 %) and neatness (51.16 %). Line × Tester exhibited high percent contribution for filament size (85.58 %) followed by reelability (63.58 %) and hatching percentage (56.51 %). Ravindra Singh *et al.* (2000) have observed high percent contribution in bivoltine lines whereas, Ravindra Singh *et al.* (2005), Gangopadhyay and Ravindra Singh (2006), Nazia Choudhary and Ravindra Singh (2006b) Haque *et al.* (2007) have found higher percent contribution in multivoltine lines. Extensive studies have been made on line × tester analysis to determine the general combining ability (GCA) and specific combining ability (SCA) effects in the mulberry silkworm (Kalpana and
Combining ability is a measure of gene action of additive and non additive. General combining ability is heritable and largely involves additive gene effects, whereas specific combining ability represents only non additive gene action (Bandyopadhyay, 1990). Among the lines, AGL₃ and AGL₅ were found good general combiners exhibiting positive significant GCA effects for ten and seven characters, respectively. Positive GCA effects for quantitative characters like cocoon yield/10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length, filament size, raw silk and reelability indicate that additive gene action is important for the inheritance of these characters. The results are in agreement with that of Jeong et al. (1986), Pershad et al. (1986), Sohn and Hong (1986), Subba Rao and Sahai (1989), Rajalakshmi et al. (1997), Ravindra Singh et al. (2000; 2001c) indicating that the additive genes actions are playing major role in the inheritance of these characters. The present findings are in agreement with that of Gamo and Hirabayashi (1983). Where they have observed dominant additive gene effects for cocoon filament length, filament size, raw silk and reelability. Predominant role of additive gene action has been observed in multivoltine silkworm breeds (Ravindra Singh et al., 2005; Gangopadhyay and Ravindra Singh, 2006). Preponderance of additive gene action for most of the quantitative characters like fecundity, cocoon yield/10,000 larvae by weight, cocoon weight, cocoon shell weight and cocoon shell percentage has been reported (Sattenahalli et al., 1989). Among the testers, CSR₂ was found good general combiner exhibiting significant GCA effects for eleven out of thirteen characters. Importance of additive and non additive gene action
for fecundity, larval span, cocoon yield, cocoon shell percentage and filament length has been studied (Pershad et al., 1986; Malik et al., 1999; Narayanaswamy et al., 2000).

Specific combining ability effects have been evaluated in thirty multivoltine × bivoltine hybrids. Two hybrids AGL₃ × CSR₂ and AGL₅ × CSR₂ were found good specific combiners. AGL₅ × CSR₂ expressed significant SCA effects for five characters viz., fecundity, cocoon yield/10,000 larvae by weight, cocoon weight, cocoon shell weight and cocoon shell percentage. AGL₃ × CSR₂ exhibited significant SCA effects for three characters viz., cocoon weight, cocoon shell weight and neatness showing predominant role of non-additive gene action for the expression of these characters. Predominant role of non-additive gene action for cocoon weight and cocoon shell weight has been observed (Sengupta et al., 1974; Bhargava et al., 1992; 1995). The findings of the present study are in agreement with that of Datta and Pershad (1988), Kalpana and Sreerama Reddy (1988), Datta et al., (2001), Rao et al., (2001a). Significant SCA effects for filament length and raw silk percentage have been reported (Ravindra Singh et al., 2005). Whereas Haque et al. (2007) have found significant SCA effects for filament length and filament size in multivoltine × bivoltine hybrids. In addition, both additive and non additive gene actions were found to play major role in the expression of some quantitative characters. viz., fecundity, cocoon weight, cocoon shell weight, cocoon shell percentage and filament length (Razdan et al., 1994; Ravindra Singh et al., 2000; Datta et al., 2001).

In India, exploitation of hybrid vigour in silkworm started during 1920’s (Sreerama Reddy and Raju, 1998). Hybrid vigour was first advocated in silkworm by Toyoma during 1906 in Japan. Heterosis in hybrids has become an important tool in
crop plants and animals (Hayes and Oslen, 1919; Bell et al., 1952; 1955). Heterosis in silkworm has been studied by several workers (Osawa and Harada, 1944; Harada, 1952; 1956; Hirobe, 1956). Heterosis has been exploited for improvement of productive and quality of desired characters that mainly contributed to silk yield (Griffing, 1956). Moll et al (1962) have reported expression of heterosis is usually more in hybrids obtained from diverse genetically related lines.

In the present study, manifestation of hybrid vigour over mid parent (MPV) and better parent (BPV) was determined in order to know the genetic interaction through mid parent value and superiority of F₁ hybrids over its better parent value. Analysis of hybrid vigour was determined in thirty multivoltine × bivoltine hybrids. Majority of the hybrids expressed their superiority in the manifestation of hybrid vigour over MPV for various characters particularly for pupation rate, cocoon yield/10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length, filament size and raw silk percentage. Expression of heterosis for different characters in the hybrids is due to partial dominance, especially for cocoon yield/10,000 larvae by weight, cocoon weight and cocoon shell weight (Rao et al 1998; 2002b; 2003). Maximum significant hybrid vigour over mid parent was observed in AGL₃ × CSR₂ and AGL₅ × CSR₂. AGL₅ × CSR₂ manifested significant hybrid vigour over MPV for six characters viz., cocoon yield (53.90 %) cocoon weight (39.31 %), cocoon shell weight (50.57 %), cocoon shell percentage (9.46 %), filament length (29.97 %) and raw silk percentage (4.84 %). AGL₃ × CSR₂ exhibited maximum significant hybrid vigour for cocoon yield (46.63%), cocoon weight (37.67 %), cocoon shell weight (50.12 %), cocoon shell percentage (11.43 %), filament length (30.68 %) and raw silk percentage (9.60 %). High degree of heterosis for
various quantitative characters is due to the influence of environmental gene action in silkworm (Harada, 1961; Griffing and Zsiros, 1971). Hybrid vigour studies in multivoltine × bivoltine silkworm hybrids have been extensively carried out by several workers (Datta, 1984; Nagaraju et al., 1989; Noamani et al., 1990; Ravindra Singh et al 1990; 1992; 1998a; 2000; 2001b).

Manifestation of significant hybrid vigour over better parent (BPV) was observed in some hybrids. Maximum significant hybrid vigour was recorded in AGL$_5$ × CSR$_2$ for cocoon yield/10,000 larvae by weight (35.99 %), cocoon weight (23.00 %), cocoon shell weight (22.83 %) and filament length (9.71 %). AGL$_3$ × CSR$_2$ showed significant hybrid vigour for cocoon yield/10,000 larvae by weight (25.53 %), cocoon weight (16.19 %), cocoon shell weight (15.72 %) and filament length (7.94 %). Sen et al. (1996) have found relationship between the degree of heterosis and genetic divergence in silkworm. Farooq et al. (2002) have detected desirable heterosis for all characters is due to increase in the genetic diversity up to a certain limit. Significant hybrid vigour for cocoon yield, cocoon weight, cocoon shell weight, filament length and raw silk percentage has been observed in multivoltine × bivoltine hybrids (Ravindra Singh et al., 2005). Considering the overall hybrid vigour analysis, it was observed that most of the hybrids exhibited desirable significant hybrid vigour over mid parent and better parent values. Two hybrids AGL$_3$ × CSR$_2$ and AGL$_5$ × CSR$_2$ expressed maximum heterosis for most of the important characters. This may be due to the wide genetic distance between genotypes. As heterosis is a function of dominance effect and genetic distance between parents AGL$_3$ × CSR$_2$ and AGL$_5$ × CSR$_2$ were found promising and adjudicated as potential heterotic hybrids combination for superior silk yield when comparison was made over the control PM × CSR$_2$. 
In the present study, analysis of RAPD profiles within the inbred lines of AGL series when amplified with OPA11 and OPD2 indicated the accomplishment of homozygosity of the lines at the molecular level. Tretjak *et al.* (1992 a; b) have reported identical patterns of hybridization in the individuals produced from the females of parthenogenetic strains through application of DNA fingerprinting method based on M13 phase DNA as a hybridization probe.

Cocoon size uniformity is an important parameter from the standpoint of silk production and evaluation to identify suitable parents / hybrids for breeding and evaluation to produce uniform cocoons with uniform filament size for quality reeling by the commercial hybrids (Nakada, 1994). Uniformity in cocoon size helps to get uniform filament size in semi-automatic and automatic reeling machine (Mano, 1994). Attempts have been made to improve the cocoon characters in multivoltine × bivoltine hybrids (Noamani *et al.*, 1990, Nagaraju *et al.*, 1987, Rao *et al.*, 2002a). Several workers have studied cocoon size variability in multivoltine × bivoltine hybrids, multivoltine breeds and bivoltine breeds (Nakada, 1994; Hirabayashi, 1982; Gamo *et al.*, 1985; Ravindra Singh *et al.*, 1998b; 2000; 2001b; Rao *et al.*, 2002a; 2003). The present study on cocoon size variability was carried out in thirty multivoltine × bivoltine hybrids. Fourteen hybrids have shown standard deviation around 8 and their coefficient of variation ranged from 3.83 to 4.99 %. Less cocoon size variation was noticed in most of the hybrids. Cocoons of AGL$_3$ × CSR$_2$ (7.08) and AGL$_5$ × CSR$_2$ (6.62) were found comparatively uniform exhibiting standard deviation < 8 for cocoon length/width ratio and CV % ranged from 4.09 to 4.23 %. Recently, studies have been carried out in silkworm hybrids (Gangopadhayay *et al.*, 2006; Umadevi and Rao, 2006).
The short listed promising multivoltine breeds and multivoltine × bivoltine hybrids were further evaluated through different statistical analyses for most of the important economic characters like fecundity, pupation rate and cocoon yield/10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length, reelability, raw silk percentage and neatness in order to know their superiority. AGL₃ exhibited its superiority for nine and eight out of ten characters based on rearing performance, evaluation index and subordinate function index, respectively. AGL₅ expressed better response for all the characters on the basis of average performance, evaluation index and subordinate function. AGL₅ and AGL₃ showed significant GCA effects for six and five out of ten characters, respectively. Among the hybrids, AGL₃ × CSR₂ and AGL₅ × CSR₂ showed desirable for seven and eight characters, respectively based on average evaluation index, subordinate function index and specific combining ability. Both hybrids indicated significant heterosis over mid parent (MPV) and better parent (BPV) for cocoon yield/10,000 larvae by weight, cocoon weight and cocoon shell weight. Moreover, the cocoons of these hybrids were found to be uniform exhibiting CV % of 4.09 and 4.23 % and their SD less than 8. In overall, on the basis of various statistical tools, among the breeds, AGL₃ and AGL₅ and among the hybrids, AGL₃ × CSR₂ and AGL₅ × CSR₂ were adjudicated as better parent and promising heterotic hybrids.

As per the laboratory performance, developed promising multivoltine × bivoltine hybrids AGL₃ × CSR₂ and AGL₅ × CSR₂ were evaluated in the laboratory along with control hybrid PM × CSR₂ to detect the percent improvement for important economic characters over the control hybrid. The present results clearly demonstrated superiority of short listed hybrids for most of the characters. Maximum
percent improvement was recorded in cocoon yield/10000 larvae by weight (21.17 and 21.14 %), cocoon weight (13.32 and 11.92 %), cocoon shell weight (26.03 and 24.13 %), filament length (24.78 and 25.77 %) and raw silk (10.27 and 11.68 %) in AGL₅ × CSR₂ and AGL₃ × CSR₂, respectively. Marginal improvement was found in fecundity, hatching, pupation, reelability and neatness over the control PM × CSR₂.

Based on the laboratory, Technology Validation and Demonstration Centre and field performance, two promising hybrids AGL₃ × CSR₂ and AGL₅ × CSR₂ were found promising and showed their superiority for desirable characters over the control hybrid PM × CSR₂, for pupation rate, cocoon yield, cocoon weight, cocoon shell weight, and cocoon shell percentage. The cocoons of AGL₃ × CSR₂ fetched the highest price of Rs.138=00 among 853 lots at Ramanagaram government cocoon market on 14-05-2008.

The findings of the present study contribute information to at least three areas of research. Firstly, they show possible utilization of androgenesis as a breeding tool in silkworm breeding for the development of homozygous bisexual silkworm breeds. Secondly, the newly developed homozygous multivoltine lines AGL₃ and AGL₅ may be utilized as breeding resource materials in future breeding programmes. Finally, the promising multivoltine × bivoltine hybrids AGL₃ × CSR₂ and AGL₅ × CSR₂ may be recommended for commercial exploitation.
In the present study, an attempt was made to develop multivoltine silkworm breeds through application of androgenesis coupled with conventional breeding technique.

Androgenesis in silkworm has a great role for the production of homozygous lines within short period of time with high survival, hybrid vigour, combining ability and less phenotypic variability.

Induction of androgenesis was performed as per Astaurov (1957).

Induction of androgenesis technique has been further modified to improve the efficiency towards androgenetic development and hatching in silkworm eggs.

Comparative studies revealed that androgenetic development and hatching was pronounced in modified method over routine one. High temperature at 38 °C for 200 min was found ideal as compared to 40°C for 135 min and 42°C for 210 min.

Twenty six multivoltine breeds were chosen from the working germplasm of Central Sericultural Research and Training Institute, Mysore.

Performance of breeds was compiled and evaluated as per Mano et al. (1993).

Top ranked five multivoltine breeds viz., DNP₃, ND₇, BL₆₈, NP₁ and DNP₅ were utilized as breeding resource materials.

Five androgenetic multivoltine lines namely, AGL₁, AGL₂, AGL₃, AGL₄ and AGL₅ were developed by series of backcrosses with androgenetic males.

The developed lines were subjected to hybrid evaluation to identify the promising hybrids and evaluated utilizing popular bivoltine breeds namely, CSR₂, CSR₃, CSR₄, CSR₁₂ and NB₄D₂.
Data were recorded for eleven economic characters such as fecundity, hatching percentage, pupation rate, yield /10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length, filament size, reelability, raw silk percentage and neatness.

Evaluation of breeds and hybrids was carried out as per multiple traits evaluation index method of Mano et al. (1993) and Sub ordinate function index method of Gower (1971).

General combining ability (GCA) of lines and testers, specific combining ability (SCA) effects of hybrids and heterosis over mid parent and better parent values were carried out as per Kempthorne (1957).

Among the lines, AGL3 and AGL5 which exhibited significant GCA effects for majority of the characters were adjudicated as better general combiners.

Among the thirty multivoltine × bivoltine hybrids, AGL3 × CSR2 and AGL5 × CSR2 expressed highly significant (SCA) effects for fecundity, cocoon yield/10,000 larvae by weight, cocoon weight, cocoon shell weight and cocoon shell percentage.

Heterosis was recorded in majority of the hybrids for most of the characters such as pupation rate, cocoon yield, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length, filament size and raw silk percentage.

Two hybrids, AGL3 × CSR2 and AGL5 × CSR2 were found promising and manifested highly significant hybrid vigour over MPV and BPV for cocoon yield/ 10,000 larvae by weight, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length and raw silk percentage over the control PM × CSR2.
Based on cocoon size uniformity, most of the hybrids expressed less variation in cocoon size. Cocoons of \( AGL_3 \times CSR_2 \) and \( AGL_5 \times CSR_2 \) were found relatively uniform with their SD<8 and CV % of 4.23 and 4.09 %, respectively.

On the basis of various statistical analyses, two multivoltine breeds \( AGL_3 \) and \( AGL_5 \) and two multivoltine \( \times \) bivoltine hybrids \( AGL_3 \times CSR_2 \) and \( AGL_5 \times CSR_2 \) were short listed.

Level of homozygosity in newly developed multivoltine lines was assessed through DNA fingerprinting.

Overall results indicated that breeds \( AGL_3 \) and \( AGL_5 \) and hybrids \( AGL_3 \times CSR_2 \) and \( AGL_5 \times CSR_2 \) showed their superiority over the control \( PM \times CSR_2 \).

Selected promising hybrids \( AGL_3 \times CSR_2 \) and \( AGL_5 \times CSR_2 \) were further evaluated in the laboratory along with control \( PM \times CSR_2 \). Data showed that new hybrids performed better in terms of cocoon yield, cocoon weight, cocoon shell weight, cocoon shell percentage, filament length and raw silk percentage over the control.

New hybrids \( AGL_3 \times CSR_2 \) and \( AGL_5 \times CSR_2 \) were further evaluated in a limited scale along with control hybrid \( PM \times CSR_2 \).
Based on the results obtained from the present thesis, certain conclusions can be drawn: -

- Androgenesis can be successfully used as breeding tool for the development of homozygous silkworm breeds.
- Newly developed multivoltine silkworm breeds AGL₃ and AGL₅ can be utilized as breeding resource materials in future breeding programmes.
- The promising multivoltine × bivoltine hybrids *viz.*, AGL₃ × CSR₂ and AGL₅ × CSR₂ may be recommended for commercial exploitation to obtain stabilized cocoon crops.