General
Introduction
SILK—The queen of Textiles, spell luxury, elegance, class and comfort. Mankind has always loved this shimmering fibre of unparalleled grandeur from the moment Chinese empress discovered it in her teacup. It withstood many a daunting challenges from other natural and artificial fibres and yet, remained the undisputed Queen of Textiles since centuries. Exquisite qualities like the natural sheen, inherent affinity for dyes and vibrant colours, high absorbency, light weight, resilience an excellent drape etc. have made silk, the irresistible and inevitable companion of the eve, all over the world.

Silk is a high value but low volume product accounting for only 0.2% of world’s total textile production. Silk production is regarded as an important tool for economic development of a country as it is a labour intensive and high income generating industry that churns our value added products of economic importance. The developing countries rely on it for employment generation, especially in rural sector an also as a means to earn foreign exchange.

Geographically, Asia is the main producer of silk in the world and produces over 90 % of the total global output. Though there are over 40 countries on the world map of silk, bulk of it is produced in China and India, followed by Japan, Brazil and Korea. China is the leading supplier of silk to the world with and annual production of 76545 MT (1999). India is the second largest producer of silk with 15241 MT (1999) and also the largest consumer of silk in the world. It has a strong tradition and culture bound domestic market of silk. India enjoys the monopoly of producing four types of silk i.e., Mulberry, Tasar, Eri and Muga, in the world. Mulberry silk is produced mainly in the states of Karnataka, Andhra Pradesh, Tamil Nadu, Jammu & Kashmir and West Bengal, while the non-mulberry silks are produced in Jharkhand,
Chattisgarh, Orissa and Northeastern states (Fig 1). The state of Karnataka enjoys the first place in raw silk production followed by Andhra Pradesh, Tamil Nadu and West Bengal. India, which was hardly producing 1,184 MT of mulberry silk in 1960, it increased its production to 15,214 MT by 1999 and in turn, it is 17,461 MT for 2001-2002. This significant expansion of the industry is the result of the contributions of research by means of introducing high yielding mulberry varieties, silkworm breeds along with the package of practices for mulberry cultivation, improved technology of silkworm rearing, crop protection measures for mulberry and silkworm etc.

Sericulture is a cottage industry found in 59,000 villages of India. And nearly 60 lakhs of persons are engaged in various sericulture activities in the country. Every 3.07-kg of silk produced and used in handlooms generates gainful employment of one-man a year. This potential is par-excellence and no other industry generates this kind of employment, especially in rural areas, hence sericulture is used as tool for rural reconstruction. Sericulture provides vibrancy to village economics for about 57% of the gross value of silk fabrics flows back to the rearers. The share of income to different groups is: 56.8% to cocoon grower, 6.8% to the reeler, 9.1% to the twister, 10.7% to the weaver and 16.6% to the trader. Thus large chunk of income goes back to the villages from the cities. Besides the low gestation, low investments and high returns encourage the entrepreneurs to take up different sericulture activities. Moreover, it is women friendly in occupation as women constitute over 60% of those employed in down-stream activities of sericulture in the country. It is an ideal programme for weaker sections of the society as 3/4 acre of mulberry garden and silkworm rearing can support a family of three without hiring
labour. And also features such as low gestation, high returns make sericulture an ideal programme for weaker sections of the society. In fact, Sericulture is an eco-friendly activity. This activity benefits sectional value-addition as it primarily accrues to rural households. As the end-products users are mostly from the higher economic groups, money flows from high-end groups to low end groups and thus satisfies equity concerns.

Presently 27 states in Indian are practicing sericulture (Fig. 1). Karnataka enjoys the first place, producing $8728^*$ tons with $120678^*$ hectares of land under mulberry cultivation. Andhra Pradesh holds the second place, producing $4774^*$ tons with $52225^*$ hectares of mulberry plantation. According to the present statistics $231372^*$ hectares of mulberry plantation is present in India. With such large land resources raw silk production must boost up. Andhra Pradesh is the second largest raw silk producer in India and Anantapur district is the largest raw silk producer in A.P followed by Chittor, Kurnool and Cuddapah districts. Geographically these areas are situated under semi-arid and sub-humid conditions. These areas receive less rainfall. Besides, delayed monsoons made the situation more critical. Despite of such conditions, Anantapur district, which envisages more drastic conditions, is still the largest producer of raw silk. The mulberry acreage of this district, under irrigated area is $23,206^*$ hectares. The popular mulberry varieties in use are Local, K 2, V 1, S 36 and S 13. In the total mulberry cultivated land K 2 and Local varieties are planted in $22,195^*$ hectares, varieties of S series are planted in $388^*$ hectares and V 1 variety is planted in $640^*$ hectares. The total raw silk production of the Anantapur district is $185.115^*$ tons. The popular silkworm breeds reared in this district are PMxNB4D2(*cross breed*), APS8X APS9 (*Kalpatharu*, *bivoltine*)

*2002 PROVISIONAL*
hybrid), APS4 x APS 5 (Hemavathi, bivoltine hybrid), APM1 x APS8 (Swarmandhra, cross breed) and CSR2 x CSR4 (bivoltine hybrid). All the mulberry cultivated land of the state of Andhra Pradesh is under irrigated conditions. The above information clearly indicates the hold of Local and K 2 mulberry varieties over the farmer. Moreover nearly 50% of the raw silk production is from PM x NB4D2 only. This shows the dependence of the sericulturists on the Local and K 2 varieties and the C.B race PM x NB4D2. This is probably due to the sustainable crop results of these mulberry varieties and silkworm race. This again may be attributed to the significant acclimatization of these mulberry varieties and silkworm race to the local environmental and atmospheric conditions.

During the last six months, prices of raw silk and cocoons across the country have slumped to pre-1990 levels. There is little doubt that this is the direct consequence of large imports of silk yarn and fabrics coming into the country at low prices. In fact, the prices of imported raw silk have fallen from a level of US$ 24.50 in March 2001 to US$ 14 in June 2002. It is difficult to explain away this fall in prices as the consequence of Indian economy being finally exposed to healthy competition from the international markets. However, for the past few months the local cocoon markets of Andhra Pradesh as well as Karnataka envisaged the lowest cocoon prices, even if the cocoons were good for reeling. This directly affects the marginal sericulturists with low investments and less land resources. To stabilize the cocoon prices the local governments as well as the central government are taking drastic measures.
It's a long cherished dream of India to become a bivoltine silk producing country for quality and export needs. And, research efforts were on since the last couple of decades to tropicalise the temperate bivoltine silkworms to suit the agro-climatic conditions of the country. The launching of a collaborative programme with the Japan International Co-operation Agency (JICA) in 1991 by the Central Silk Board, India to evolve a bivoltine technology has now proved to be an Indian sericulture industry as it could relish the dream into a reality. Presently the slogan of Indian sericulture is 'Bivoltine sericulture'. The necessity to meet the domestic demand and to sustain it in the world market with increasing trade has driven Indian sericulture to enrich its research resources and renew the policies. In this direction, the successful introduction of bivoltine sericulture to traditional multivoltine areas of Karnataka and Andhra Pradesh states through JICA programme is a turning point to South Indian sericulture. However, there are so many sericulture-practicing areas still under the hold of traditional cross breed rearing with mulberry gardens of traditional local varieties.

Mulberry is the natural and basic food of silkworm, *Bombyx mori* L. It comes under the family Moraceae and belongs to the genus *Morus*. It originated at the lower Himalayan belt of Indo-China region and found to be distributed in both the hemispheres. It can be cultivated as low bush, high trunk or deep-rooted forest tree. It is a hardy plant capable of thriving under a variety of agroclimatic conditions. It is raised as a leafy crop in sericulture and responds extremely well through luxuriant vegetative growth to optimum agronomic practices like irrigation, fertilizer application and manuring. But when the plant nutrients and soil moisture begin to operate as limiting factors, the growth is stunted and the leaf yield is considerably reduced.
The mulberry leaf moisture percentages, its retention capacity and nutrient value of the tropical and temperate varieties widely differ which can be attributed to the low quality of the silk produced in the tropics. To overcome these problems continuous efforts are being made at the research institutes of India. This probing resulted in the evaluation of some elite mulberry varieties for replacing the established low yielding varieties.

The majority of area under Indian mulberry plantation is within the local variety prevalent in that particular area. In south, it is Mysore local and in West Bengal, the Kajli local. The local variety is characterized by small, multi lobed, papery and less nutritious leaves with low moisture percentage and low moisture retaining capacity despite having a good establishing capacity. The next variety is K 2, which is preferred by farmers, the performance of this is better than the local variety under irrigated as well manured conditions. Silkworms fed with K 2 leaves show significant increase in the larval weight, cocoon weight, shell weight and filament length over that of the local variety (Krishnaswami et al., 1971). Some of the evolved varieties such as S 30, S 36, V 1, S 41 and S 54 were reported to be promising under irrigated conditions of South India. Varieties S 13 and S 34 were recommended for rain-fed high temperature conditions. The variety Anantha was recommended for the Rayalaseema zone, particularly for Anantapur district. However, a farmer is not sure enough to decide which variety of mulberry he has to cultivate for better silk production and higher income. This is due to the lack of sufficient information on the yield potentials of these evolved mulberry varieties and their performance to achieve successful cocoon crop. Since mulberry is perennial and survives for more than ten years, one has to be careful during the
selection of a variety. Evaluation of mulberry germplasm is not just the same with those of other plants. Because, unlike rice or wheat, the yield in not the only criteria to evaluate the mulberry. In this case, attention must be paid not only to increase the output of leaves, but also to obtain leaves of superior quality. There is a popular saying, 'A thousand kilograms of mulberry leaves, but no cocoon' which emphasizes, especially the importance of the superior quality leaves. Two important criteria need to be considered while selecting a variety. The variety should not only be high yielding but also it should support the healthy growth of silkworm larvae including the quality and quantity of cocoons, the larvae would produce (Aruga, 1994). Datta (1992) reported that raising mulberry leaf of high nutritive value is the most crucial pre-requisite for successful rearing of silkworms. Further, he reported that irrigation plays the most important role followed by the optimum time given for the leaf to attain proper maturity to get a successful crop. Since mulberry cultivation plays a major role and takes about 60% expenditure in sericulture (Rangaswami et al., 1976), efforts are to be concentrated to increase the production of quality foliage.

Mulberry is cultivated more in South India under irrigated, semi-irrigated and rainfed conditions. However, more than 40% of mulberry area in India is under water stress conditions (Susheelamma and Jolly, 1986). Most of the morphological and physiological characters associated with crop growth and development are affected mainly by water stress (Kramer, 1959). Mulberry varieties, which are more resistant to water, stress conditions would be of great importance to sericulture farmers settled under semi-arid conditions. Very few studies are available regarding this aspect and all the research was done only under temperate conditions (Susheelamma and Jolly, 1986). As such necessity is
felt for the evaluation of better mulberry variety under semi-arid conditions. Nevertheless, no evaluation is sufficient with its yield performance, as the ultimate product influenced is the silk. In this context, it is necessary to evaluate all the genotypes for their propagational, growth, yield, quality through feeding studies. In view of the present understanding, the study being reported herein was carried out to evaluate the superior mulberry genotype to suit the semi-arid zones. The evaluation was carried under complete irrigated conditions, as the mulberry cultivation in Anantapur as well as other districts, with semi-arid atmosphere, is taken up under irrigated conditions only. Elite mulberry varieties like S 13, S 30, S 36, S 34, Anantha, V 1 and MR 2 along with K 2 as control have been used for the present study. Previously these varieties were not evaluated under semi-arid conditions with irrigation. Parameters associated and correlated with the performance of the variety as well as silk yield were taken into consideration. They are as follows.

i. Vegetative propagation parameters like sprouting and rooting.

ii. Growth and yield characters like the longest shoot length, number of leaves per meter, average leaf area, leaf yield, shoot yield, leaf area index, biological yield (total aerial bio-mass), and the harvest index.

iii. Leaf biochemical analysis for moisture content, moisture content after 12 hrs of excision, total soluble sugars, total carbohydrates, total nitrogen, total crude protein, total soluble protein, total crude fibre, total chlorophyll and total chlorophyll 'a' & 'b'.

iv. Rearing performance of PM x NB4D2 and CSR2 x CSR4 with the selected mulberry varieties was studied. Under these moulting performance during I\textsuperscript{st} and II\textsuperscript{nd} instars, larval weight, larval
duration, ERR by number & weight, single cocoon weight, single shell weight, shell ratio were studied. Under post cocoon quality parameters average filament length and filament denier were studied.

The chief objective of the present work is to bring out the suitable mulberry variety for the semi-arid zones based on the overall performance in the above mentioned parameters. In addition, the aim of the study is to establish a superior variety for the irrigated mulberry gardens suitable for both cross breed and bivoltine silkworm races. For the present study, Maize Selection Tool (MST) has been employed to rank the mulberry genotypes in respect of propagation, growth & yield, biochemical and bioassay parameters. Ranks thus obtained for different parameters were discussed for the final recommendation of suitable mulberry variety under semi-arid conditions.
Fig. 1. Silk Map of India

Source: indiansilkboard.com