INTRODUCTION
INTRODUCTION

*Dalbergia sissoo* Roxb., commonly known as ‘Shisham’ is one of the most important tree species in India. It is a member of the plant family leguminosae and the subfamily Papilionoideae. The genus *Dalbergia* contains 200 to 300 species distributed throughout the tropics and subtropics. *Dalbergia sissoo* is the most widely cultivated and economically important member of the genus in Asia.

1.1 Distribution

Shisham is found in many parts of India up to 900 m in the sub-Himalayan tract and occasionally ascending to 1500m. It is found in Jammu & Kashmir, Himanchal Pradesh, Punjab, Haryana, Rajasthan, Uttar Pradesh, Delhi, Bihar, Orissa, West Bengal, Sikkim, Arunachal Pradesh, Assam, Nagaland, Manipur, Mizorum, Meghalaya, Tripura, Madhya Pradesh, Gujarat, Maharashtra, Andhra Pradesh, Pondicherry, Tamilnadu, Karnataka and Kerala. In the sub-Himalayan tract, it occurs along rivers and streams, gregariously growing on alluvial soil.

1.2 Phenology

Leaf fall takes place generally in November-December. Young leaves appear about the end of February and leafing is complete by early April making, April to May the best time of the year for the production of high - quality fodder (Jackson, 1987). Young flower buds appear along with new leaves. Leaves turn brown prior to falling. The flowers generally open in March and April. Pale green young pods appear by the end of April and become full sized and finally turn brown and ripen during November-December.

1.3 Morphology

It is a medium sized deciduous tree, 10-30 m tall often with crooked trunk up to 2-4 m in girth at the base and a clear bole up to 35 ft. under favourable conditions. Leaves are imparipinnate and alternate. Leaflets 3-5, alternate, terminal leaflet larger. Flowers are yellowish white. Pods are linear, oblong, indehiscent, usually 1-4 seeded. Seeds are reniform and compressed. In seedling the stem is erect, thin and green. Leaves alternate, first simple then trilobate followed by 5-foliolate (Troup, 1921). It is adapted to a seasonal monsoon climate and a dry season of up to 6 months. Seedlings are intolerant of shade.
1.4 Silvicultural Characters

The *sissoo* is a very hardy species, a strong light demander, capable of growing under adverse soil and moisture conditions and on saline soils, a frost hardy species, wind firm but is not fire resistant. It cannot tolerate stiff clay, and requires porous, well aerated ground for its proper development. The seedling produces a long taproot at an early stage; this thickens considerably during the sapling stage, becoming much gnarled and twisted by contact with boulders. The lateral roots may attain considerable strength and thickness and spread at a depth of a few inches to about 2 ft. below ground surface, frequently sending up root suckers. Sowing is carried out between the middle of March and the middle of June; however, earlier sowing is preferred.

1.5 Reproduction

The light flat pods are disseminated by wind or by water and remain in the ground from the beginning of December till the end of April, and lie until June and July when they become sufficiently soaked by monsoon rain to cause germination. The factors which favour the development of saplings are full light, a highly porous soil, freedom from weeds and as a rule, sufficient moisture in the soil to tide over the dry season. They can be grown vegetatively from root cuttings. However, such methods are not in vogue, as the tree can be raised so easily from seed.

1.6 Uses

* Agro forestry: - The tree species is most suitable for agro-forestry plantations and can be raised successfully with various agricultural crops like maize, mustard, grain, peas, wheat, sugarcane and cotton crop.

* Fodder: - Young branches and foliage form a nutritious fodder with a dry-matter content of 32.46%, crude protein 27-24.1% and is utilized in silvipastoral purposes.

* Fuel: - The species is fast growing and hence suitable for firewood.

* Fibre: - Sulphate pulp from its wood is used in producing writing and printing paper.

* Timber: - *D. sissoo* is one of the most useful timber species of India. The heartwood is very hard, seasons well, does not warp or split, is strong and durable, least susceptible to dry-wood termites in India, takes a good polish and is brown with dark figures, for which it is prized for furniture and general constructional work. It is used for high quality decorative veneer, cabinets, marine and aircraft grade ply woods, ornamental turnery,
carving, engraving, tool handles and sporting goods. Its root wood is used for tobacco pipes. In village industry it is popular for doors and windows.

* Pesticide: - Aqueous extracts from the leaves, stems and roots inhibit the reproduction, growth and development of the insect pest _Utetheisa pulchella_. Mixed with _Azadirachta indica_ oil cake, sawdust from _D. sissoo_ reduces egg laying and increases larval mortality in _Meloidogyne javanica_.

* Medicine: - Oil obtained from the seeds is used to cure skin diseases. The powdered wood, applied externally as a paste, is reportedly used to treat leprosy and skin diseases. The roots contain tectoridin which is used medicinally.

* Shade and Shelter: - It has been established in irrigated plantations along the field boundaries, along road sides and canals, around farms and orchards and coffee and tea plantations as windbreaks.

* Reclamation: - Due to its vigorous reproduction through suckers, it is useful for stabilizing eroding sites. It is therefore found in a variety of wastelands, where it is known as a colonizing species.

* Nitrogen Fixing: - The nodules improve soil fertility.

* Soil Improver: - Heavy litter fall decomposes to enrich the soil with nitrogen, phosphorous and organic carbon.

* Intercropping: - It may be planted as one component of a multitier home garden system, where it contributes several products.

* Ornamental: - Widely used in urban and roadside plantings in the Indian sub-continent and in other parts of the world.

### 1.7 Plant-Insect Interactions

Insects are known to have been quiet adaptable in meeting the vicissitudes of life that they are the only creatures that dispute dominance of man on earth. In the process they got adapted to various modes of life and exploited quite a good range of variety of food available on earth.

The phytophagous lepidopteran species that most often impinge on human economy and life styles by causing direct damage to the plants, thus establish an antagonistic association with plants providing no benefit to the plant in return.
Macrolepidopteran foliage defoliators are particularly harmful but microlepidopteran larvae although small, often occur in such numbers that can cause considerable damage.

Their larval stages feed on the foliage and defoliate the young and old trees. Some defoliators roll a leaf or bind two or more leaves together making a fold for shelter. These insects use silk to hold leaves together in various ways to provide a retreat in which they moult or spend their inactive periods, feeding on the leaf tissue inside the shelter. Hence, they are known as “leaf rollers” or “leaf binders”. These leaf eating caterpillars feed on the foliage and defoliate the tree. Due to the larval feeding, the young as well as old trees are affected showing leafless condition in severe insect attack. In severe outbreaks by lepidopteran defoliators, crops and trees can be completely stripped off the foliage. Severely damaged foliage may lose much of its photosynthetic capacity and the tree growth is adversely affected.

Shisham has a rich complex of insect fauna of about 125 insect pests associated with it, only 10 are known to have attained economic status and have been recognized as potential pests of nurseries and plantations. Defoliators of *D. sissoo* represent primarily a group of caterpillars of several lepidopteran families which cause tremendous damage to the trees in forests every year. The important lepidopteran defoliators of Shisham are-*Plecoptera reflexa* Guenee, *Plusia orichalcea* Fabricius (Lepidoptera: Noctuidae); *Ascotis infixaria* Walker, *Ascotis selenaria* imparata Walker (Lepidoptera: Geometridae); *Laspeyresia jaculatrix* Meyrick (Lepidoptera: Eucosmidae), *Dichomeris eridantis* Meyrick (Lepidoptera: Gelechiidae); *Leucoptera sphenograpta* Meyrick (Lepidoptera: Lyonetiidae); *Archips micacea* Walker (Lepidoptera: Tortricidae). The defoliator, *Dichomeris eridantis* Meyrick (Lepidoptera: Gelechiidae) is basically a leaf binder of Shisham. It is widely distributed in India and Pakistan in association with *Dalbergia sissoo*. It is reported as an important pest of Shisham particularly in irrigated plantations, and in the absence of the principal defoliator *Plecoptera reflexa*, may be of local importance and destroys half the canopy in the season from June to August (Fletcher, 1932; Beeson, 1941). Therefore, the species is sometimes an important pest, the most severe defoliation usually occurring between June and August.

1.8 Pest outbreaks

In most agroecosystems there are numerous phytophagous species, most of which do not cause any significant damage because they do not normally occur in
sufficient numbers but they have the potential to become pests. If a pesticide treatment is done, it releases such a population from the regulatory factors that normally keep it in check, thereby causing a new (secondary) pest outbreak to develop. Forestry practices create an environment more favourable for growth of populations of insects that have the potential for becoming pests. Monoculture favours more food supply, less competition and less density related mortality, pest multiplication and increase in pest population. Also, often there is something about a new environment that allows a species to increase in numbers much more rapidly once it has become established there than it did in its place of origin (Elton, 1958). Frequently the introduced species are not serious pests in their place of origin because of various environmental constraints, including weather and natural enemies. But in the new environment they are freed from such constraints and become pests.

1.9 Management

Pest problems, particularly in forestry and agriculture, are population problems. On the worldwide basis the insect pests annually destroy about 14% of the total potential crop production amounting to more than US $ thirty-five million (Grainge et al., 1988). On the other hand the explosion in human population continuously kept the demand for food rising thus pressurising the food resources and the farmers to increase the food production manifold. In the given situation heavy losses incurred due to insect pests needed immediate attention. The situation thus demanded an effective means to combat this problem. The pesticides based on petrochemical derivatives comprising organic hydrocarbons, carbamates and others proved effective and have been in use for the past 50 years throughout the world with a flourishing global agrochemical market estimated to be of US $ 26.8 billion in 1991 of which US $ 7.75 billion is exclusively that of only insecticides (Powell and Justum, 1993). Modern insecticide development really began with the discovery of the potent insecticidal properties of DDT. Their extensive use since then and particularly in the last decade has been intensified drastically because of their broad spectrum applicability and effective control of insect population.

But most of them have proved disastrous to man and environment by leaving toxic residues (Matusumura, 1980), develop resistance in insects and kill beneficial insects (Brown, 1978). Most of the species feed on green plants and consequently are in direct competition with man, requiring counter measures and control.
Once we determine that a pest problem exists, we normally respond with a control tactic designed to make the environment less favourable to the pest and thereby reduce its number. Various practices have been used to control these insect pests and chemical pesticides have proved very effective. But direct pest control, such as the application of a pesticide, while making the environment unfavourable for a short time, may in fact make it more favourable in the long run. Pesticide treatment of a crop ecosystem frequently produces a spectacular but temporary decline in the pest population. Being toxic and non-biodegradable, they have proved disastrous and a potential threat for the existence of life on earth. Moreover, they led to development of chemical insecticide resistant strains of the pest, environmental hazards and ecological imbalance, pest resurgence and ill effects on non-target organisms. Absence of natural enemies, favourable nature of most crop environments combined with pest resurgence, secondary pest outbreaks and more susceptible host plants have too often resulted in the need to repeat the use of some pesticides which has led rapidly to pesticide resistance by a large variety of insects. Once resistant to chemical suppression, an insect becomes a new pest with an increased potential for causing economic damage. Realising his folly of heavily depending on these toxic chemicals, man has started looking for an environmentally safe, ecofriendly, effective and biodegradable control method to control these pests. The alternative lies in the use of bio pesticides.

1.9.1 Bio pesticides

Bio pesticides are potential chemicals of biological origin (plants and microbes) with diverse biological activities (toxicants, insect growth regulators, feeding deterrents, repellents, sterilants, antifungal compounds) which affect the insect pests adversely. Use of bio pesticides in place of chemical pesticides is the essence of ecofriendly control. Bio pesticides have been gaining increased attention and interest among those concerned with developing environmentally friendly and safe tactics for pest management (Copping and Menn, 2000). A survey on the European market alone for bio pesticides predicted bio pesticide sales to reach US $ 167 million by year 2004 (Neale, 2000). The growth rate of bio pesticides over the next ten years has been at 10-14% per annum, in contrast to 2% for chemical pesticides (Menn, 1996).

Bio pesticides include in broader sense, pesticides of biological origin. Thus, the encouragement of natural enemies (parasitoids, predators, microbes, etc.) and the use of
transgenic crop varieties, pheromones, growth regulators and plant-derived materials in pest management constitute the bio pesticide umbrella.

1.9.1.1 Types of bio pesticides

At the end of 2001, there were approximately 195 registered bio pesticide active ingredients and 780 products. Bio pesticides fall into three major classes:

*Microbial pesticides* consist of a microorganism (e.g., a bacterium, fungus, virus, protozoan or its byproducts) as the active ingredient. These microbes are non-toxic and do not load the environment with deadly poisons. Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest. The most widely used microbial pesticides are subspecies and strains of *Bacillus thuringiensis*, or Bt. Each strain of this bacterium produces a different mix of proteins, and specifically kills one or a few related species of insect larvae. The target insect species are determined by whether the particular Bt produces a protein that can bind to a larval gut receptor, thereby causing the insect larvae to starve.

*Plant pesticides* are pesticidal substances that plants produce from genetic material that has been added to the plant. For example, scientists can take the gene for the Bt pesticidal protein and introduce the gene into the plant's own genetic material. Then the plant, instead of the Bt bacterium, manufactures the substance that destroys the pest.

*Biochemical pesticides* are naturally occurring substances that control pests by non-toxic mechanisms. Biochemical pesticides include substances, such as insect sex pheromones that interfere with mating, as well as various scented plant extracts that attract insect pests to traps.

1.9.1.2 Advantages of Bio pesticides

- Bio pesticides usually are inherently less harmful than conventional pesticides.
- Bio pesticides generally affect only the target pest and closely related organisms, in contrast to broad-spectrum conventional pesticides that may affect organisms as different as birds, insects and mammals.
- Bio pesticides often are effective in very small quantities and decompose quickly, thereby resulting in lower exposures and largely avoiding the pollution problems caused by conventional pesticides.
● Bio pesticides when used as a component of Integrated Pest Management (IPM) programs, they can greatly decrease the use of conventional pesticides, while crop yield remains high.

1.9.2 Pest management principles

As per the pest control principles and practices - Effective pest control may be described as reduction or maintenance of pest population below the damage threshold. To use bio pesticides effectively, however, users need to know a great deal about managing pests.

The degree of injury (damage to the foliage) to a plant is related to the density of the pest population (number of insects per plant) and the stage of larval development of the pest causing more injury to the plant. The time of pest injury during the developmental stage of the plant also affects the growth, quality and quantity of the yield of the plant. Young seedlings are very susceptible to the insect pest injury. In 1961, the Australian entomologists P.W. Geier and L.R. Clark coined the phrase pest management programmes in which control methods fit into the biology of the pest species. They also emphasized the recognition of ecological principles in pest control programmes. The most suitable definition is quoted by Brader (1979), which states that-“Pest management is a system that, in the context of the associated environment and the population dynamics of the pest species utilises all the suitable techniques and methods in as compatible a manner as possible and maintains pest populations at levels below those causing economic injury.”

Thus, data regarding establishment of the pest status requires regular sampling of the pest population and the beneficial species and continuous monitoring of the other regulating features including the environmental features, is very important to make an accurate assessment of population trends with time. This in turn provides information as to the necessity of control measures and suggest ways of manipulating it. Moreover, the most vulnerable stage in the life cycle and establishment of the economic threshold are essential for effective pest control programmes.

Thus, the detailed Biology of *D. eridantis* still needs to be worked upon as there is a vast gap in the information. Moreover, the most damaging stage, extent of damage, population fluctuation trends with time, effect of various environmental factors on various life cycle parameters needs to be studied so as to exploit ecological factors and
natural mortality factors to design an effective optimal control strategy for the pest *D. eridantis* on Shisham.

Hence, there is an urgent need to gear up and coordinate research work on biopesticides, *viz.* Botanicals, microbials, biorationals, parasitoids and predators. Proper cataloguing and region wise surveys of natural enemies (parasitoids, predators, pathogens) should be conducted to determine their biodiversity. We also need to have focussed promotion of botanicals in general and there should be concerted efforts to promote botanicals as an important component of IPM.

To conclude, biopesticides have come to stay and must be exploited. What is needed is to strengthen our resources and accelerate our endeavours to replace environmentally hazardous conventional chemical pesticides with these eco-friendly biopesticides. In view of the potential future and wide scope presented in this area, I have taken up this project so as to make my contribution towards environmental conservation with the following objectives:-

### 1.10 Aims and objectives of the proposed research

1. To study the detailed biology and life history of *Dichomeris eridantis* on Shisham.
2. To study the seasonal fluctuation and the extent of damage.
3. To study the energy budget of the pest.
4. Effect of different temperatures and humidity on the development of egg, larva, pupa and adult.
5. To trace the environmentally safe, effective and practicable control measures against the pest in laboratory and field.
   a) To test the efficacy of botanicals and identified microbes.
   b) To test the efficacy of commercially available biopesticides (plant and microbial origin).
   c) To standardize the dose of the effective biopesticides for their application in the field.