1.1. IMPORTANCE OF STORED GRAINS

Pulses are an important part of the vegetarian diet of the Indian subcontinent, being a rich source of protein and have high nutritional value. India is the largest producer of pulses, accounting for 28% of global production of pulses. In many developing countries, pulses supply a high proportion of the plant proteins which are the main and cheapest sources of proteins. Hence they are known as “poor man’s meat”.

India being the major pulse growing country in the world accounting roughly to one third of the total world area under pulses and one fourth of total world production. In India 22.83 million hectare of land is under pulses cultivation with annual production of 11.21 million tonnes. In Tamilnadu, pulses are cultivated in 8.2 lakh ha with the production of 3.71 lakh metric tonnes. Black gram is the major pulse, produced in Tamilnadu and it is grown in an area of 4.5 lakh ha, and its production is 2.05 lakh tonnes with productivity of 461 kg ha-1 (Anonymous, 2001).

Food and agriculture organization reported that 8.5 percent of grain loss occurs during post harvest handling and storage in India. Losses in pulses due to infestation of bruchids have been reported by Mookherjee et al., (1970) and Gangrade (1974).

1.2. INFESTATION OF THE PULSE BEETLE, CALLOSOBRUCHUS MACULATUS ON STORED GRAINS

Seeds of pulses are heavily damaged by pulse beetles (bruchids) in storage. The pulse beetles attack the pods of pulses in the field from where they are carried to godown. They completely destroy the endosperm of seed leaving only seed coat. Thus, seed loses its
viability *Callosobruchus chinensis*. Linn; *Callosobruchus maculatus* Fab and *Callosobruchus analis* Fab are the most common species of pulses beetle found in India (Raina, 1970).

Several species of bruchids in the genus *Callosobruchus* are known to damage grains of legumes up to 93.3 percent during storage. Among the five species of *Callosobruchus* three species viz., *Callosbruchus maculatus*, *Callosbruchus chinensis* and *Callosbruchus analis* are commonly found in India. Controlling bruchids through use of synthetic insecticides leads to several problems like resistance and residual hazards rendering the product unfit for human consumption. The Pulse beetle *Callosobruchus maculatus* is one of the most destructive pests of stored pulses. This pest multiplies rapidly under warm humid conditions and causes serious damage within a short time. *Callosobruchus maculatus* infests seeds of wild and cultivated legumes especially *Vigna radiata*. It has probably been associated with human stored of grain legumes in Africa for several thousand years (Mitchell, 1983).

Cereals and pulses are the staple food of the people and are stored in godown for a few months to an year, where they are attacked by a number of stored grain insect pests. Almost all the insect pests of stored grains have a remarkably high rate of multiplication and within a few months they may destroy 10-15% of the grains and contaminate the rest with undesirable odours and flavours. Further, the insect infestation in stored products is high in the tropics and may lead to 100% damage in severe cases (Egwuatu, 1987).

Several bruchids species attack cereals and pulses in store and cause a loss of 10-15% with a germination loss ranging from 50 - 92 % (Adugna Haile, 2006). *Callosobruchus maculatus* is one of the major pests of stored cowpea in the tropics (Sharma, 1984 and Raja *et al.*, 2001). Lal (1988) reported that in India, food grains loss during storage at the farm level was about 10%.
1.3. BOTANICALS AND STORED GRAIN PEST CONTROL

The use of plant products as insecticides could be broadly classified under powders or fresh application, volatile oils, non-volatile oils and extracts in application technology. Plant powders often prevent or reduce the emergence of adult beetles from the seed. Van Schoonhoven (1978) showed that vegetable oils of different purity varied in toxicity to eggs.

Essential oils have a low toxicity to warm – blooded animals, high volatility and toxicity to store – grain insect pests (Shayya et al., 1997). Numerous plant species are reported to possess pest control chemicals, but only few of them seems to be ideally suited for management of stored grain weevils. Reduction in oviposition, hatching and adult emergence in *Callosobruchus chinensis* (Pandey and Srivastava, 1997). Laboratory and field trials have demonstrated that the botanical insecticides affect insect pests in many ways as oviposition deterrent, antifeedant growth disruptant and insecticidal effect (Saxena, 1993).

Botanical insecticides play a much important role for their non-toxic effects and moderate efficacy without leaving any residues in the environment. Among the several botanicals used for crop protection purposes, *Azadirachta indica* are popularly called neem or margosa which has a vast potential in insect pest management. Neem seed kernel, oil, pulp and husk are found to possess pesticidal properties. Neem products possess anti-feedant and repellent properties because of compounds like isoprenoids, glycerides, polysaccharides, flavonoids, aliphatic compounds etc. (Devakumar and Sukhdev, 1993). Among the chemical constituents, Azadirachtin is the most potent and abundant one having antifeedant and ecdysis inhibition properties on several major pests. Leaves and kernels of *Azadirachta indica* slightly increased the adult mortality of *C. maculatus* (Seck et al., 1991). Oviposition of *Callosobruchus maculatus* was completely inhibited after seed treatment with *Pongamia pinnata* (Bhaduri et al., 1990). Screening plant extracts for their deleterious effect on insects
is one of the best approaches used for the search of new botanical insecticides (Jacobson, 1975; and Isman, 1995). The foliage powder of *Calotropis gigantea, Ocimum sanctum* has been found to be insecticidal against several stored product pests (Ryan and Byrne, 1988).

### 1.4. BOTANICALS AS PESTICIDES

The plant world comprises a rich store house of biochemicals that could be trapped for using as insecticides. The toxic constituents present in plants represent the secondary metabolites and have only insignificant role in primary physiological processes in plants that synthesize them (Cooper and Johnson, 1984). Some of the secondary metabolites are merely the end products of aberrant biosynthetic pathways.

Effective control of stored-grain pests with minimal pesticide use requires an Integrated Pest Management approach combining sanitation, monitoring and other preventive practices. Sanitation involves cleaning bins, elevators and other conveyers before new grain is put in storage, the goal being to eliminate insect eggs, larva, pupa, and dormant adult that will eat and grow in the stored grains. Though the plant derivatives were introduced in the market and integrated pest management is launched at farmer’s level, India’s consumption of bio-pesticides (Botanicals and microbial pesticides, parasitoids, predators, pheromones and growth regulators) are less than 1% against 12% globally. Therefore, the union ministry agriculture is concerned with slow progress in IPM as there is an increasing demand for chemical pesticides, put at 50464 tonnes in the year 2000-2001 as against the 44381 tonnes in the previous year (Ignacimuthu, 2002). Adugna *et al.* (2003) suggested an alternate for the synthetic pesticide to tap plant resources, which have evolved astonishingly diverse array of pesticidal but safe chemical molecules.
1.5. INFESTATION OF *SITOPHILUS ORYZAE* ON STORED GRAINS

*Sitophilus oryzae* is considered as a major pest of stored grains. Control of this insect relies heavily on the use of synthetic insecticides and fumigants. But their widespread use has led to some serious problems. Different types of plant preparations such as powders, solvent extracts, essential oils, and whole plants are being investigated for their insecticidal activity including their action as fumigants, repellants, antifeedants, anti-ovipositions and insect growth regulators (Isman, 2000).

Long-term storage of grains leads to severe infestation and extensive damage by *Sitophilus oryzae* (L) (Gupta et al., 2000). Dunkel et al. (1991) showed that the extract of *A. indica* seeds (0.2 percent w/w) applied to wheat caused 50 percent mortality in adult *S. oryzae* (L.) and 15 percent mortality in *Rhyzopertha dominica* (Fabricius) within three days and F1 emergence was reduced by 98 and 94 percent respectively.

Prakash et al. (1990) showed that Z-heptatriacontanone isolated from the leaves of *V. negundo*, when admixed with rice at 400 mg per Kg reduced oviposition in *S.cerealella*, *R.dominica* and *S.oryzae*. The legume *tephrosia* (*Tephrosia purpurea*) contains insecticidal properties and an antitumor compound, lupeol (Beckstrom-stenberg and Duke, 1994).

Chemical composition of the essential oil from *Artemisia scoparia* and its fumigant and repellent activity were investigated against three stored product insects, *Callosobruchus maculatus* (Fab.), *Sitophilus oryzae* (L.), and *Tribolium castaneum* (Herbst). (Maryam Negahban et al., 2008).
1.6. MICROBIAL CONTROL OF STORED GRAIN PESTS

The microbial pesticides are entomogenous microorganisms or their products which exert pathogenic effects and are usually fatal to their insect hosts. The viruses, such as the nuclear polyhedrosis viruses (NPV), cytoplasmic polyhedrosis viruses (CPV), granulosis and non-inclusion viruses, some fungi and bacteria are commercially available in various formulations and under different trade names. The common trade names of bacterial pathogen, *Bacillus thuringiensis* are Thuricide, Bakthane and Larvatrol etc.

*Serratia marcescens*, its chitinases and its chitinase genes have shown potential for biocontrol agents in a variety of experimental set-ups (Brurberg *et al.*, 2000). This bacterium is an insect pathogen and chitinase plays an important role in the virulence of this bacterium together with protease and lecithinase (Uchiyama *et al.*, 2003).

Strains of *Metarhizium anisopliae* from diverse geographical origins have been characterized to test their virulence against storage Bruchidae pests of maize, beans, rice and other agricultural crops (Cherrya *et al.*, 2005; Murad *et al.*, 2006; 2007). The use of entomopathogenic fungus become a reliable alternative for coleopteran pests control as an alternative to chemical control and has been extensively investigated. (Adane *et al.*,1996).

Control of *C. maculatus* currently relies on several strategies as the use of chemical insecticides (Tederson *et al.*, 2006), biological control (Jackai and Adalla, 1997) by using bacteria, protozoa, nematodes, virus and fungus (Chapman, 1974; Legner, 1995). *Beauveria bassiana* and *Metarhizium anisopliae* were evaluated according to their virulence toward storage maize bruchid pests (Cherrya *et al.*, 2005) showing that their proteinaceous secretions could be utilized as biotechnological tools in the development of novel bioinsecticides and/or construction of resistant genetic modified plants. Ten *M. anisopliae* isolates were found
virulent against *C. maculatus* while performing enzymatic and proteomic analysis (Murad et al., 2006).

So in the present study, it has been planned to find out suitable botanicals and microbicides to control the major pests *C. maculatus* and *S. oryzae* that damages the stored grains to the greatest extent.