Chapter-1

INTRODUCTION

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Pulse crops have play an important role in Indian agriculture. Besides being rich in protein and other biochemical substances, they sustain the productivity of the cropping systems. Their ability to use atmospheric nitrogen through biological nitrogen fixation (BNF) has earned their fame as economically sounder and environmentally acceptable crops. Pulses occupy 67.8 million hectares area and contribute 55.2 million tonnes of the world's food basket. Asia is the major pulse producing continent sharing 52.1% of the global hectarage (Chhabra, and Kooner, 1998). India is the largest pulse producing country and contributes to 35% of worlds' area and 27% of production. These crops account for one-fifth of the cultivated area and one-twelfths of the food grains production in India. In Indai, the pulse production per year is around 15 million tonnes (Kumar, 2000). Of the total production in India 60% is grown as rabi crop and 40% as kharif crop. Pulses account for roughly 20% of the total area under food grain crops and contribute to about 08.3% of the total food grain production in the country. The area under pulse crops in India at present is around 23 million ha, the production is around 15 million tonnes and the productivity is about 650 kg/ha. India will need at least 23 million tonnes of pulses by 2005 AD and 30 million tonnes by 2020 AD. Thus, a boost to the production and proper management are required at the national level (Asthana and Chaturvedi,1999). The commonly grown legume crops in India are green gram, chick pea, pea, pigeon pea, black gram, horse gram, lentil, moth bean, kidney bean, Indian or country bean and soybean. Though pulses are grown in almost all parts of the country, the important pulse producing states are Madhya Pradesh, Rajasthan, Uttar Pradesh, Maharastra, Orrisa, Karnataka, Andhra Pradesh, Hariyana, Bihar and West Bengal. The most drought-tolerant among kharif pulses are green gram, pigeon pea, horse gram, moth bean and those among rabi pulses are green gram, grass pea, lentil, cowpea and other beans. Every pulse plant is in itself a mini-fertilizer factory for fixation of atmospheric nitrogen to the soil.

In a country like India where a large population is vegetarian, the cheap and best sources of protein are still the pulses. On an average, pulses contain protein about 2.5-3.0 times higher than that in the cereals. On account of a balanced amino acid composition in blend proteins of cereals and pulses, which matches the milk protein, the importance of pulses in vegetarian diet cannot be over emphasized. Since pulses are cheaper than animal proteins, they are often referred to as "poor man's meat" in a developing country like India (Chaturvedi and Ali, 2002). The pulse seed contains protein, carbohydrate, lipid, mineral and bio-chemical substances

(Appendix XIII) and rich in lysine and poor in sulfur containing amino acids, a reverse situation exits in the cereal protein (Jeswani and Baldev, 1987).

Of many insect pests the Pulses are badly damaged by pulse beetles of the genus *Callosobruchus* (Coleoptera : Bruchidae) during storage throughout the world and this discourages the poor farmers from large-scale production and storage of pulses. Moreover, the amount of moisture in the seed is one of the important factors influencing the length of time the seeds remain viable. Seed moisture is a function of relative humidity **(Appendix VII)**; seeds have an equilibrium moisture level in relation to the relative humidity around them. Air can hold only a certain amount of water vapour or moisture at any given temperature. A considerable quantity of stored pulses is rendered unsuitable for consumption due to attack of stored grain insect pests. After the induction of high yielding cultivars the production of pulse crops has been increased significantly over the years and use of comparatively better production technology. In storage, these are damaged by various agencies such as insects, micro-organisms, rodents and moisture, which cause colossal quantitative and qualitative losses. The quantitative losses of food grains in storage have been estimated to be 9.33% in India in comparison to other underdeveloped countries where these losses are as high as 30 – 50 % (Harein and Clarke, 1995). The Expert Committee, Govt. of India estimated that loss at threshing yards is 1.68% during transport 0.15%, during processing 0.92% and in post-harvest storage the post harvest loss is about 9.30% **(Appendix VIII)** The pulses are stored by farmers in indigenous storage structures where the maximum losses occur. The food grains are virtually living organisms. Hence, the grains should be stored as a living seed. A grain is physiologically quite stable after harvesting and this stability as well as viability should be preserved by adopting a good storage method. Under natural conditions, stored grains undergo chemical changes. Its further deterioration is caused by external living organisms, such as insects, microorganisms, moulds, fungi, mites and rodents.

Bruchids are serious world wide distributed group, most abundant in the tropics, whose larvae develop inside seeds, most preferred hosts belong to the leguminous family and al together other 24 plant families have been recorded as host by Southgate (1978). Approximately 1300 species of bruchids have been recorded, mostly attack the growing crops, but they get carried into stores in the ripe pods and seeds and some species are successfully able to continue their development in the dry seeds (Hill, 1990). Few other pests such as the rice moth *(Corcyra cephalonica)* rice weevil *(Sitophilus* spp.) and red floor beetle (*Tribolium* spp.) also damaged stored pulses. Besides these pests, a few saprotrophic insects, mites, fungus by way of render the pulses unconsumable.

The pulses have to be stored either for short or long duration for utilization in future for human consumption, animal feeds and as seed. Pulses are stored by the farmers mainly in indigenous store structures in the rural areas where the maximum losses occur. No up to date accurate estimation of losses have been published so far although the results of a survey on stored pulses conducted in India (**Appendix IX**) indicated a maximum of 98%, 73%, 64%, 46%, 29% and 4% infestation in mung bean (*Vigna radiata*), grass pea (*Lathyrus sativus*), chick pea (*Cicer arietinum*), lentil (*Lens culanaris*), black gram (*V. mungo*) and pea (*Pisum sativum*) respectively by the pulse beetles *Callosobruchus chinensis* Linnaeus and *C. maculatus* Fabriceous after 6-8 months of storage (Mookherjee *et al.*,1970). The seed losses of cowpea due to *C. maculatus* were reported to be as high as 30% in India (Shivankar *et al.,* 1989) and an average loss of 14.92% of black gram in storage by *Callosobruchus* sp. in different parts of India (Mookherjee *et al.*, 1970). In tropical and sub-tropical regions the losses of stored pulses due to pulse beetle were shown to the tune of 60% and 20% respectively (Casewell, 1973 and De Teledo, 1946). As a result of improved storage technology, these losses in government warehouses could be reduced but at farmer's level where the maximum produce is stored, the losses are still too high. Pests of stored products are widespread over the globe and cause much damage due to their high resistance to unfavorable conditions, their high fecundity and fast development. Potentially, these pests can infest various kinds of stored grains, but their distribution in a country or in an area is usually determined by storage climatic factors.

In India, stored pulses are damaged by pulse beetles such as *C. chinensis* Linn.,*C. maculatus* Fabr., *C. analis* Fabr., *C. affinis* Frol., *C. emerginatus* All., *C. phaseoli* Gyll., *C. albacallosus* Pic., and *C. pisorum* Linn. Among these, *C. chinensis* is the most serious pest in India and also abroad. However, all species and varieties of stored pulses are not equally susceptible to the attack and damage. Although the accurate estimate is not available, pulses in storage suffer from a substantial damage due to bruchids. According to Mookherjee *et al.* (1970), the degree of damage caused by *C. chinensis* was mung bean> grasspea > chickpea > lentil > black gram > pea (**Appendix IX**). Only five species of bruchids of the genus *Callosobruchus* are was known from India of which three species the most important pests of stored pulses (Raina,1970). These are *C. chinensis*, *C. maculatus* and *C. analis*. These three pests feed on several hosts such as green gram, red gram, cowpea, bengal gram, grass pea, pea, lentil, black gram and moth bean.

The Terai agro-climatic region of West Bengal includes the area of entire Coochbehar and Jalpaiguri district, Siliguri sub division of Darjeeling district, and Islampur sub division of Uttar Dinajpur district (**Appendix XI** and **Plate 1**) Pulses are generally grown and store in traditional ways and thereby results in huge loss. The production of pulses in this region is very low as compared to that of West Bengal and Indian average due to inherent soil-climate and pest-disease complex of this region. However, there is immense possibility of improving production in different districts of this region are furnished in **Appendix-II**.

As per the available technologies, the use of contact insecticides and few fumigants for the large scale storages is common practice in India. As a prophylactic measures premium grade contact insecticides has been used since 1954in storage (Islam, 1999). Their use has several problems, such as environmental pollution, development of resistance by the pests, high cost and sometimes non-availability. Moreover, the use of these chemicals against pests is hazardous to small farmers because of their traditional storage practices, knowledge-gap of using proper dose of chemicals and financial constraints. Insecticides have been found very promising in suppressing the pulse beetles, but they are hazardous to mammals. Their use results in the development of high degree of resistance in insects and the edible legume seeds are rendered toxic to mammals. The development of resistance and cross-resistance to insect pests, death of natural enemies and harmful effect on human health become a great problem to stored grain insect-pest management. Bhujbal *et al.* (2001) have studied the efficacy of several insecticides and their residual toxicity. These adverse effects of insecticides necessitate diversified efforts for evolving more convenient and safer protection strategy.

In the recent past, the use of indigenous plant materials or botanicals has assumed an important position in the modern approach of pest control, as they are comparatively safe to the mammals due to their biodegradable nature. Pest management can not operate without accurate estimates of pest and densities of natural enemies. Keeping in view the hazards from excessive use of chemicals on stored grains, researchers have attempted the management of various stored grain pests by oneness of certain indigenous plant products and such rational has gained worldwide attention. Numerous plant species have been reported to possess pest control chemicals (**Appendix X**) but only few of them seem to be ideally suited for management of stored grain pests. Plants afford a rich source of chemicals with diverse biological activities. So far over 200 plant species belonging to 60 families are known to possess insecticidal properties (Dhaliwal and Arora, 1998). A number of minor insecticides of plant origin have also been identified for the presence of pest control chemicals (**Appendix X**).

Moreover, the concept of bio-control is easy and economic to deliver through seeds. In storage, the seed treatment with bio-control agents can easily bė applied by the seed producrs at the time of their seed processing. The cost of such treatment is extremely low and practically negligible whereas the benefits are several folds. In view of these advantages, research on developing further products of bio-control agents and their methods of application is sure to pay high dividends to researchers, farmers, commercial firms as well as the society. Therefore, a fillip to research in this line is an urgent need in our country.

The assessment of occurrence, distribution and abundance of pest and parasitoids are essential prerequisites to rational control programmers. This becomes possible by undertaking a survey, especially a qualitative and quantitative survey which involves the identification of the different species occurring over an area. Extensive works on relative susceptibility and extent of damage to different species of stored pulses by *Callosobruchus* spp. have not yet been done in the present investigation.

An extensive survey has been carried out covering a vast area of Terai Agro-climatic regioni.e. Northern part of West Bengal, India to detect species of pests and their natural enemies of stored pulses for assessing the status of populations / damage, studying the influence of weather (Appendix II) **and seasonal factors** (Appendix III) **on pests and natural enemies, recording new species of pests and parasitoids, monitoring the behavior of pests and natural enemies populations, marking endemic districts, and for adopting suitable management schedule for suppressing the pest population. This region in a greater sense is characterized by a distinctive Agro- climatic area** (Appendix III)**. There are local variations within this area. Accordingly, the nature and extent of damage of stored pulses by a particular pest species vary according to local conditions. Concomitantly the dynamics of pest infestation and the status of damage of the stored legume seeds are expectedly of different dimension. These warrant the investigation of the bio-ecology and their suitable management of important stored legume pests.** The management strategy will preferably be a safer and non-toxic one. The foregoing account of current status of knowledge on stored pulse pests and potentiality of their management with the help of botanicals and parasitoids deals with one or other aspects of the complexity of problem as a whole. Many workers have studied the bio-ecology of stored grain pests in different climatic zones of India and abroad. But no body in this region has undertaken work on this aspect. This justifies the undertaking of a comprehensive study on the problem in context to Terai Agro-climatic region, where the present study has been carried out. This region has a distinctive potentiality of pulse production. But because of very poor storage facility and lack of storage protection know how, farmers do not find any impetus for large-scale pulse production. Therefore, thorough base level information is required for this area to generate knowledge and transfer of knowledge to the farmers. Keeping this in mind the present work has been designed as under:

- Survey of pests and their bio-control agents on storage pulses at Terai Agro-climatic conditions of West Bengal, India.
- Studies on the bio-ecology of *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae) on the green gram (*Vigna radiata*) in laboratory condition.
- Studies on bio-ecology of *C. analis* Fabr. (Coleoptera: Bruchidae) on green gram (*V. radiata*) in laboratory condition.
- Studies of host preference and adult emergence of both *C. chinensis* L. and *C. analis* Fab. on different species of stored pulses during summer and winter seasons.
- Effect of seed weight, thickness of seed coat, moisture and phenol contents of fourteen species of pulses on the persistency of both *C. chinensis* and *C. analis.*
- Morphological studies of naturally occurring two potential key parasitoids of bruchid pests, [the egg parasitoid, *Uscana mukerjii* (Hymenoptera: Trichogrammatidae) and the larval pupal parasitoid, *Dinarmus vagabundus* (Hymenoptera:Pteromalidae)], in a reversionary frame work including their historical and taxonomical background.
- Studies on the biology and parasitization potentiality of, *Uscana mukerjii* in controlling *C. chinensis.*
- Studies on the biology and role of, *Dinarmus vagabundus* in controlling *C. chinensis.*
- Effectiveness of different plant oils at different concentrations on adult *C. chinensis.*
- Efficacy of plant oils in controlling *C. chinensis* on stored green gram up to 120 days