Chapter I

1. General Introduction

1.1. Background

Mungbean (*Vigna radiata* (L.) Wilczek) is one of the most important legumes of the arid and semiarid tropics (Chen *et al.*, 1987; Pannu and Singh, 1987). It is an ancient and well-known crop throughout Asia. Mungbean originated in South and Southeast Asia: India, Burma, and Thailand region (Gowda and Kaul, 1982). However, this crop is now widely grown in India, Thailand, Bangladesh, Pakistan, Nepal, Burma, Philippines, China, and Indonesia. It is also grown in parts of East and Central Africa, the West Indies, USA and Australia. In Thailand, mungbean is considered as a very important crop not only for domestic consumption but also as export commodity.

Mungbean is an excellent source of easily digestible protein of low flatulence, which complements the staple rice diet in Asia (Nine, 1986; Chen *et al.*, 1987). It is used to prepare food products at both the household and the industrial level. The protein and fat content of mungbean is 23.33 and 1.17 percent respectively (Prabhavat, 1990). In addition to protein and fat content, it is rich in vitamin A, B_1, B_2, niacin and vitamin C, potassium, phosphorus and calcium (Prabhavat, 1990). Vermicelli, salim starch, low cost high protein foods, protein supplementary foods, different kinds of deserts, and main dishes are produced from mungbean. Moreover, the mungbean residues after extraction of protein and starch are used as animal feed for the animal feed industry. Furthermore, the mungbean sprout is well known as vegetable for different kinds of delicious oriental dishes. Other common uses include fodder for livestock, and green manure to enrich soil as they have the ability to fix atmospheric nitrogen (N_2) in association with bacteria (Chen *et al.*, 1987; Miller and Fernandez, 1987).

Since mungbean is a short durable legume (maturing 55 to 70 days), it fits well into many cropping systems, including sugarcane under rainfed and irrigated condition, increases small farmers' incomes, and improves soil conditions (Fernandez and Shanmugasundaram, 1987; Singh *et al.*, 1987).

Blackgram (*Vigna mungo* (L.) Hepper) is a close relative species of mungbean (Gowda and Kawl, 1982; Yang, 1987). It is also an important tropical legume crop, which is native to Asia (Indian subcontinent). It is widely grown in India, Thailand, Bangladesh, Pakistan, Nepal, and Burma. In tropical parts of Africa and in the West Indies, it is mainly grown as green manuring crop (Gowda and Kawl, 1982). Blackgram is one of the important highly nutritious pulses, providing grain for human consumption and fodder for cattle. It contains high protein and carbohydrate. The protein content in blackgram ranged from 24.0 to 27.0 percent (Pichitporn and Thavarasook, 1990). The seeds are cooked commonly as dehusked split or whole dal. The dehusked grain is used to prepare several snacks and dishes. The broken stems and pod-walls remaining after threshing are used as cattle feed (Gowda and Kawl, 1982). Blackgram is grown for fodder in many parts of Bangladesh and used as green manuring crop to enrich depleted soils (Gowda and Kawl, 1982). In many countries, blackgram is used for the preparation of bean sprouts especially in Japan. The sprouts of blackgram give a fresh white appearance for longer period than mungbean (Chainnuvati *et al.*, 1987). Therefore, the demand for blackgram in foreign markets, especially in Japan, for the bean sprout industry is increasing (Prabhavat, 1990).

Despite the significance of these two crops in human and animal nutrition, and cropping systems, their production is severely constrained by multitude of factors. Various diseases are posing continuous challenge in realizing the potential of these crops (Nine, 1986; Pal, 1996). So far 27 diseases including 11 caused by fungi have been recorded which cause several diseases of mungbean and blackgram (Deng, 1984; Yang, 1987). Among the different fungi, *Macrophomina phaseolina* (Tassi) Goidanich is a serious plant pathogenic fungus that attacks a wide range of hosts including mungbean and blackgram. It is considered as one of the major pathogens of mungbean and blackgram in Thailand (Chinsawangwatanakul and Surin, 1980; Chainuvati *et al.*, 1987), Bangladesh (Khan *et al.*, 1977; Gowda and Kaul, 1982), India (Shukla and Bhargava, 1976; Grewal, 1988; Pal, 1996), Pakistan (Basir *et al.*, 1987), Somalia (Ossoble, 1987), and Vietnam (Quyen, 1987).

Macrophomina (subdivision Deuteromycotina, form-class Coelomycetes) is a genus composed of a single species, *M. phaseolina* (Tassi) Goid (Mihail, 1992). Holliday and Punithalingam (1970) listed the synonyms of this fungus: *Macrophomina phaseoli* (Maulb.) Ashby, *Macrophomina Philippines* Petr., *Macrophoma phaseolina* Tassi, *Macrophoma corchori* Sawada, *Macrophoma cajani* Syd. & Bult., *Macrophoma sesami* Sawada, *Sclerotium bataticola* Taub., *Rhizoctonia bataticola* (Taub.) Briton-Jones, *Rhizoctonia lamellifera* Small, and *Dothiorella cajani* Syd. & Bult.

However, *Macrophomina phaseolina* is a seed-borne and soil-borne pathogen that affects on seed quality by reducing seed viability, seed and seedling vigour (Nath, 1970; Neergaard, 1979; Grewal, 1988). It causes stem and root rot, leaf blight, and leaf spot of mungbean and blackgram (Neergaard, 1979; Grewal, 1988). The disease is generally called 'charcoal rot' and this fungus is also found to cause diseases in many crops (Dhingra and Sinclair, 1977 cited in Hooda and Grover, 1988; Neergaard, 1979; Holliday, 1980; Dhar and Sarbhoy, 1989; Burman and Lodha, 1996). In addition, as a seed-borne fungus, *M. phaseolina* causes physio-chemical changes and deterioration in seed content. Furthermore, *M. phaseolina* also produces blackish lesions on edible bean sprouts (Nath, 1970; Neergaard, 1979; Grewal, 1988). Blackgram is an important export commodity for Japanese and Indian markets from Thailand and the main utilization are making bean sprouts. But, the Thai blackgram often complains by the importers to be of subnormal quality due to seed contamination by *M. phaseolina*, which causes rotting of domestic sprouts (Chainnuvati *et al.,* 1987; Putasamai and Surin, 1988; Pichitporn and Thavarasook, 1990).

1.2. Rationale

Significance of the pathogenic fungi *M. phaseolina* is paramount. However, plenty of works have been carried out on *M. phaseolina* as a seed-borne pathogen on various crops, albeit the works especially found on this aspect on mungbean and blackgram are still lacking.

Fungi associated with mungbean and blackgram seeds should be identified specially in Thailand, although some mungbean seeds have been already examined (Weerated, 1995). It has been reported that *M. phaseolina* infects the seed of mungbean (Scholefield and Griffin, 1979) and blackgram (Putasamai and Surin, 1988; Pichitporn, 1990). Nevertheless, no attempt has so far been made comprehensively to determine the actual pathogenic effect of this seed-borne fungus in the seed of these two crops.

Sharada and Shetty (1987) reported that *M. phaseolina* could be transmitted from seed to seedlings in blackgram in India. However, no any records regarding seed transmission of *M. phasolina* in mungbean has been found. Especially being an important pathogen there is no work has been done in Thailand so far. Hence, particularly in case of mungbean and blackgram, detail studies are still demanding as to the seed transmission including the location detection within the seed of the pathogen.

The fungus *M. phaseolina* affects on seed quality by reducing seed viability and vigor. Still no report has been published on the adverse effect of this pathogen in the seed of mungbean and blackgram. In addition to quality deterioration, this fungus causes biochemical changes in the seed. However, in this aspect there is a obvious gap of knowledg. Therefore, the effect of this fungus is required to be examined not only on seed quality but also on the major bio-chemical components such as protein and carbohydrate content.

Some chemical based control measures against *M. phaseolina*, like seed treatment with seed dressing fungicides have been in practice for the last few decades (Jain and Khare, 1972; Sinha and Khare, 1977; Reddy and Subbayya, 1981; Watanasit and Thanomsub, 1995). Still the options of chemicals for overcoming fungal resistance against prevailing fungicides are limited. In addition, less hazardous chemicals, which are effective against this predominant fungus, should be explored. Moreover, it is also needed to provide choices to the farmers for the selection of fungicides based on cost-effectiveness; and in case one fungicide is out of stock in the market, farmers can use another alternative.

Nevertheless, chemical control measures are now becoming obsolete primarily due to two reasons. Firstly, many of them are attributed to cause apparent health hazards and are not biodegradable in nature that leads to biological magnification of the toxicity in the successive food chain. Secondly, the pathogenic system is dynamic in nature, which undergoes continuous evolution giving rise to new resistant races that in turn renders the prevailing fungicides not effective for controlling pathogen. Therefore, sound pest management strategy embracing various feasible control measures has become imperative. The other potentially better alternative measures of controlling this seed-borne pathogen by seed treatment, such as heat therapy, biological control are to be duly explored.

Hence, there is a great need as well as ample scope for comprehensive studies on some pathological aspects of seed quality and control measures of *M. phaseolina* on the seeds of mungbean and its closely related species blackgram.

1.3. Objectives

The present study on seed infection of mungbean and blackgram incited by *M. phaseolina* for bridging the important gaps in knowledge as mentioned earlier and its control was undertaken with the following set of objectives thereby contributing to the successful production of high quality of mungbean and blackgram:

- to determine the prevalence of fungi associated with mungbean and blackgram seeds.
- to find out the pathogenicity of seed-borne *M. phaseolina* in mungbean and blackgram seeds, seedlings and mature plants.
- to study the transmission of *M. phaseolina* from the seed to seedling of mungbean and blackgram.
- to determine the effect of *M. phaseolina* infection on seed qualities (seed viability, vigor, storability, carbohydrate content and protein content) of mungbean and blackgram seeds.
- to control seed-borne *M. phaseolina* of mungbean and blackgram through physical (hot water), chemical (fungicides) and biological (antagonists) seed treatment.