

## CHAPTER X

### 10. Conclusions and Recommendations

Among various fungi associated with the seeds of mungbean and blackgram, *Macrophomina phaseolina* is the most pervasive and detrimental one. Its virulence is manifested right from the seed germination to advanced stage of lifecycle of plants. Based on the present study, seed coat is the prime site of *M. phaseolina* inoculum in mungbean and blackgram seeds. During seed germination, the pathogen can be transmitted from seed coat to germinating seeds and seedlings causing germination failure, leading to rotting of seeds. The pathogen can transmit to the cotyledonary leaves and the infection can spread upward and downward direction resulting in the death of whole seedling. The infected dead seed and seedlings contain profuse mycelia, microsclerotia and pycnidia, which become the inoculum for further disease cycle.

The investigation established that *M. phaseolina* has several detrimental effects on mungbean and blackgram in various ways. Firstly, it reduces the germination of seeds and degrades the quality of edible sprouts. On the infected seeds and sprouts, copious pycnidia and microsclerotia are produced during infection. Although radicles develop initially in most of the seeds, they turn into brownish color within two to three days and get rotted without initiating any plumule. The pathogenicity tests proved that *M. phaseolina* could infect the seed, seedling, and the mature plants. Secondly, *M. phaseolina* decreases seedling vigor and seed storability. The study also established that the infection of the pathogen brings about depletion of carbohydrate and concomitant increase in protein content of the seeds. Hence, the pre-emergence and post-emergence fates of the infected seeds might be ensued from both biochemical changes in the tissues and

pathogenic toxicity. Therefore, human consumption of *M. phaseolina* infected sprouts might have health implications.

Variety of seed treatment methods viz. hot water treatment, chemical seed treatment with fungicides, and use of biological antagonists appeared to be promising for abating seed pathogenicity of *M. phaseolina*. In hot water treatment, 56°C to 58°C for 10 to 20 minutes for mungbean and 56°C to 58°C for 15 to 20 minutes was found to be suitable for complete eradication of seed-borne *M. phaseolina* thereby increasing seed germination. Among six chemical fungicides (Thiram, Metalexyl, Captan, Dithane M-45, Vitavax and Benlate) tested in the present study, Benlate, Dithane M-45, and Thiram showed the best performance for complete elimination of seed-borne *M. phaseolina* for mungbean and blackgram in both *in-vitro* and *in-vivo* trials. Seed treatment with these three fungicides at the rate of 3.0g per kg seed not only eliminated the pathogen but also augmented the germination significantly. Finally, *in-vitro* experiments with biological antagonists showed that *Trichoderma harzianum*, *T. hamatum*, and *T. viride* are potentially effective inhibitor of *M. phaseolina*. However, the bacterial antagonists (*Pseudomonas aeruginosa*, *P. putida* and *Bacillus cereus*) failed to show any promising antagonistic activity. When the spores of fungal antagonists were used in seed coating, all of them were able to eliminate seed-borne *M. phaseolina* thereby enhancing germination noticeably.

Therefore, based on the results of the present investigations the following recommendations may be drawn:

1. As a considerable number of *M. phaseolina* frequently gets associated with mungbean and blackgram seeds and has various detrimental effects, so routine seed health test for these two crops need to be introduced.

2. Transmission study showed *M. phaseolina* could be transmitted effortlessly through seeds of mungbean and blackgram. Therefore, in case of infected seed, seed treatment must be recommended before plantation.
3. The investigation showed protein content gets higher due to *M. phaseolina* infection. So, further study should be needed to identify the amino acids, which are responsible for protein content alteration.
4. Regarding different types of seed treatment for controlling *M. phaseolina*, following may be recommended:
  - a) Hot water treatment: For mungbean and blackgram 56°C to 58°C for 15 to 20 minutes.
  - b) Chemical seed treatment: Any one of the three fungicides viz. Benlate, Thiram and Dithane M-45, at the rate of 3.0g for 1kg of seed.
  - c) Biological seed treatment: The spores of any one of the three fungal antagonists viz. *Trichoderma harzianum*, *Trichoderma hamatum* and *Trichoderma viride*, can be used for seed treatment at spore concentration  $7 \times 10^7$  per ml.

Nevertheless, for final recommendation of seed treatment to the farmers, research of these perspectives need to be carried out elaborately.