

PHYTOPATHOLOGICAL INVESTIGATION AND BIOMETRIC  
STUDIES OF FUNGAL DISEASE IN FRENCH BEAN  
( *Phaseolus vulgaris* L. )

By

Chetry

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THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENT OF  
THE DEGREE OF

**DOCTOR OF PHILOSOPHY IN BOTANY**

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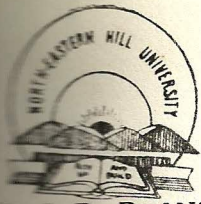


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**DECEMBER, 1989**



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## SUPERVISOR'S CERTIFICATE

I certify that the thesis entitled: "**Phytopathological Investigation and Biometric Studies of Fungal Disease in French Bean (*Phaseolus vulgaris* L.)**" submitted by Gopal Kumar Niroula Chhetry for the Degree of Doctor of Philosophy of the North-Eastern Hill University, Shillong embodies the record of original investigation carried out by him under my supervision. He has been duly registered and the thesis presented is worthy of being considered for the award of the Ph.D. Degree. This work has not been submitted for any degree of any other University.

Place: Shillong

Date: December 1989

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## ACKNOWLEDGEMENTS

I sincerely express my deep sense of gratitude and heartfelt devotion to Professor **R.R. Mishra**, F.N.A.Sc., F.N.I.E., Department of Botany, School of Life Sciences, North-Eastern Hill University, Shillong for suggesting the problem, giving constant guidance, valuable suggestions and supervision throughout the course of investigation.

I also express my gratitude to Dr. **G.D. Sharma**, Reader, Department of Botany, NEHU, for his kind and continuous encouragement, help and suggestion from time to time.

I am thankful to Professor **A. Chakraborty** and Professor **B.P. Singh**, Department of Statistics, St. Anthony College, for their suggestions and valuable assistance in Statistical analysis.

I owe my gratefulness to Professor **K. J. Mahale**, Vice-Chancellor, Professor **P.K. Bose**, Chancellor's nominee and Professor **H. Tombi Singh**, Department of Life Sciences, Manipur University for granting study leave and giving inspiration and encouragement to the present endeavour.


I am greatly indebted to **Janu** and **Taran** who have been the constant source of inspiration for me.

Thanks are also extended to all my well wishers and co-workers who have rendered their generous help.

Last but not the least, I owe everything to my family members and relatives for their good wishes for higher studies.

Place: Shillong

Date: December 1989



GOPAL KUMAR NIROULA CHHETRY

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## GENERAL INTRODUCTION

Beans (Phaseolus vulgaris L.) are widely grown legumes all over the world. This crop is extensively grown in Latin America particularly in Brazil and Mexico. The second most important areas of production is Eastern and Central Africa. In both these regions, a substantial proportion of the crop is grown in association with maize on small farms in predominantly subsistence system in which there are few added inputs (Allen and Russell, 1986). Southern Mexico and Central America are considered to be the primary centre of origin, while Peruvian-Ecuadorian-Bolivan area to be the secondary centres of origin of French bean (Bose and Som, 1986).

French bean cultivars are broadly classified as Dwarf or Bush type and Climbing pole types. Most of the local types native to North-Eastern region of India are pole types (Parthasarathy, 1986).

French bean can be grown on all types of soils except extreme acidic and alkaline, medium textured silt loam or clay loam are best for obtaining high yields (Parthasarathy, 1986).

French beans are grown as winter crop in plains, while in hills it can be grown throughout the year except winter season. In North-Eastern Region, particularly in Meghalaya, pole beans are grown from March to December. French bean is sown during September to November in South Indian plains, during February in north Indian plains, while it is grown from April to October in the hills (Parthasarathy, 1986).

Foliar diseases of P. vulgaris caused by Colletotrichum lindemuthianum and Phaeoisariopsis griseola (Sacc.) Ferraris are distributed in worldwide in many tropical and temperate regions (Inglis et al., 1988). Important reviews on the pathology of Phaseolus vulgaris (Zaumeyer and Thomas, 1957; Schwartz and Galvez, 1980) have referred principally to American conditions. The nature and prevalence of bean diseases varies considerably with environment. In Latin America, beans produced at intermediate to high altitude (1700-2800m) are affected by virus (BCMV), anthracnose (Colletotrichum lindemuthianum), aschochyta blight (Aschochyta Phaseolorum), angular leaf spot (Phaeoisariopsis griseola), rust (Uromyces appendiculatus), powdery mildew (Erysiphe polygoni), white leaf spot (Pseudocercospora albida) and grey leaf spot (Cercospora vanderysti). Beans produced

at lower altitudes and under hotter conditions are liable to infection by rust, angular leaf spot, web blight (Rhizoctonia solani) and various root rots.

This economically important vegetable crop (French bean) though thrives best in North Eastern Hill region in general and Meghalaya in particular with their abundant rainfall, high humidity and highly drained soil, is prone to many fungal diseases, important being the leaf spot resulting heavy losses in vegetable economy. More attention needs to be given to the various aspects of the disease problem of this vegetable crop in the field.

Most of the major diseases in French bean are seed-borne in nature. Impact of fungi on seeds is to reduce yields of seeds both qualitatively and quantitatively. Saprophytic and very weak parasites may lower the quality of seeds by causing discoloration. Relatively very less information related to fungi associated with the French bean seed is available (Lokhande et al., 1986, Santosh et al., 1986. Muniz and Muchovez, 1987) and therefore, investigations were undertaken to study the seed borne mycoflora associated with the French bean seeds and their seasonal variations.

The microbiology of aerial plant surface has received increased attention (Sinha, 1965; Preece and Dickinson, 1971). It is now well established that a large number of micro-organisms inhabit the phylloplane of crop plants (Leben, 1965; Preece and Dickinson, 1971).

The term "phyllophere" has been introduced independently by Last (1955a) and Ruinen (1961) and subsequently "Phylloplane" by Dickinson (1965) for phyllosphere of Last. Since then the study of phyllosphere microflora has attracted the attention of different workers (Lamb and Brown, 1970; Sinha 1971; Dickinson, 1971; 1976; Mishra and Srivastava 1971b, 1974; Mishra and Tiwari 1976b).

Qualitative and quantitative composition of micro-organisms on the leaf surface as well as their activities exhibit an interrelation between plants and micro-organisms. Physico-chemical characteristics of leaf surface environment is also important for better understanding of the population dynamics of phylloplane mycoflora (Mishra and Tiwari 1976b). The interaction of the phyllosphere saprophytic micro-organisms with foliar pathogen of the crops and consequent changes in disease potential have been studied by few workers (Leben, 1965; Fokkema, 1976; Skidmore and

Dickinson, 1976).

Leachates on the leaf surface attract micro-organisms. The different microbial population in such an environment interact with one another for space and nutrients. The role of phylloplane saprophytic fungi in biological control in certain epidemic diseases may be important and if properly exploited it may offer an alternative to synthetic fungicides (Srivastava et al., 1981; Purkayastha and Bhattacharya, 1982).

Relatively few studies dealt with the spatial distribution of disease (Strandberg, 1973; Rouse et al., 1981; Campbell and Pennypacker, 1980; Boivin and Sauriol, 1984). Since the number of sample necessary to obtain an estimate of the density of the diseased plants with a known precision varies with the spatial distribution of the disease in a field (Southwood, 1978), therefore, dispersion statistics are required to establish sampling procedures.

Boivin and Sauriol (1984) used the Iwao's regression parameters to establish the sequential sampling plan. The advantage of Iwao's procedure is that it does not require a theoretical mathematical model approaching the

spatial distribution of the pathogen (Boivin and Vincent, 1987). Since the evaluation of the diseased density before and after fungicide treatment involves an important part of the human and economic resources in disease monitoring, efficient sampling is quite essential. Sequential sampling is one such sampling procedure which allows the observer to estimate the population density of a disease after each sample with respect to the economic threshold. Sampling methods specially the statistical ones are greatly affected by spatial distribution. Spatial distribution can also provide useful information on the etiology of diseases or their method of spread through a field or area (Strandberg, 1973). Sequential sampling can reduce time and labor costs associated with disease monitoring by deciding whether or not control is needed, while staying within a pre-determined error level, instead of giving an exact estimate of the disease level (Boivin and Sauriol, 1984).

Keeping these points in view, the spatial distribution of leaf lesions caused by Colletotrichum lindemuthianum of three locally cultivated French bean was studied and the dispersion statistics obtained was used in the establishment of sequential sampling plan to determine disease level in the field. This sampling plan may also be useful

for the estimation of disease level in the field before and after the application of fungicide. The count data of leaf lesions were also fitted using the negative binomial distribution. Thus, spatial distribution was studied by using mean crowding relation and statistical distribution model.

The count data were also subjected for the analysis of variance to test the significant difference of varieties with regard to their susceptibility of the leaf lesions.

In certain areas of biological research the parametric assumptions of the shape of the distribution is only partly fulfilled. However, in many instances in which the underlying distribution is not known, or even if known they are found to be some other distribution than normal. In such cases non-parametric methods are very useful.

In the present investigation the distribution of Colletotrichum leaf spots was found to follow negative binomial distribution, analysis of variance with the assumption of normal distribution is erroneous and therefore, a non-parametric test such as the Friedman two way analysis of variance and Kruskal-Wallis one way ANOVA test by ranks

were followed for the analysis of leaf spot data from the Randomized Complete block design besides other applicable non-parametric tests.

The present investigation has been classified into the following five chapters:-

- i) Survey of leaf spot fungal diseases associated with the French bean (Phaseolus vulgaris L.).
- ii) Screening of seeds for fungal association.
- iii) Assessment and analysis of phyllosphere fungal population.
- iv) Interaction studies between leaf surface fungi and the leaf pathogen.
- v) Spatial distribution, sampling plan and analysis of variance of leaf lesions.