CAUSE AND MANAGEMENT OF FUNGAL DISEASES OF SOME MEDICINAL AND AROMATIC PLANTS

THESIS

Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
for the Degree of

MASTER OF SCIENCE
IN
AGRICULTURE
(PLANT PATHOLOGY)

By
BOREKAR KIRTI CHINTAMANRAO

DEPARTMENT OF PLANT PATHOLOGY
POST GRADUATE INSTITUTE, AKOLA

DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
KRISHINAGAR PO, AKOLA (MS) 444104

Enrolment Number - CC/551

2010

23/09/10

DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled **"CAUSE AND MANAGEMENT OF FUNGAL DISEASES OF SOME MEDICINAL AND AROMATIC PLANTS"** or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or Scientific Organisation. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

Place : Akola.

Date : 31 / 05 /2010

(Borekar Kirti Chintamanrao)

Enrolment No. CC/551

CERTIFICATE

This is to certify that the thesis entitled **"CAUSE AND MANAGEMENT OF FUNGAL DISEASES OF SOME MEDICINAL AND AROMATIC PLANTS"** submitted in partial fulfilment of the requirement for the degree of "**Master of Science In Agriculture (Plant Pathology)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Borekar Kirti Chintamanrao** under my guidance and supervision.

The subject of thesis has been approved by the Student's Advisory Committee.

Place : Akola
Date : 31/5/2010

S. T. Ingle
Chairman,
Advisory Committee

Countersigned

Associate Dean,
Post Graduate Institute
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Dr P. D. K. V. AKOLA

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE INCLUDING EXTERNAL EXAMINER (AFTER VIVA–VOCE)

1. Chairman Dr. S. T. Ingle
2. Member Dr. B. T. Raut
3. Member Dr. V. R. Gupta
4. Member Dr. S. G. Wankhade
5. External Member (Dr. R.W. Ingle)

ACKNOWLEDGEMENT

While traveling on the path of life and education many minds and hands pushed me forward, learned souls put me on the right paths and enlighted me with their knowledge, experience and wisdom. Words cannot express my profound sense of gratitude and devoted thanks to them all, without which it would never become possible for me to achieve this tremendous academic exercise and goal in life. It is my great privilege and immense pleasure to acknowledge all persons who have been helpful during the entire course of investigation.

I consider myself fortunate and greatly privilege in availing this golden opportunity to express my deepest sense of gratitude and humble indebtedness towards my honorable chairman Dr. S. T. Ingle, Assistant Professor, Plant Pathology Section, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, for his kind, generous and valuable guidance, constant inspiration, helpful suggestions, keen interest and constructive criticism right from the selection of this research work. His encouraging words always filled me with sense of courage in very trying situation during the course of this investigation. I achieve my cordial thanks to this name for the parental affection that he holds towards him and me.

With illimitable pleasure, I evoke on record personal indebtedness to member of my advisory committee, Dr. B. T. Raut, Professor and Head, Plant Pathology Section, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Dr. V. R. Gupta, Assistant Professor, Department of Plant Pathology, College of Agriculture, Akola and Dr. S. G. Wankhade, Professor, Agril. Chemistry and Soil Science and I/C Nagarjune Research Unit for their intellectual stimulation, kind suggestions and comments during the investigation.

I also wish to record my cordial thanks to Dr. S. S. Mane, Head, Department of Plant Pathology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. I am graceful to him for providing all necessary facilities during my course of investigation.

My inexplicable gratitude goes to Dr. D. L. Sale, Dean, Faculty of Agriculture, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, for providing all necessary facilities during my course of study.

I also gives me great pleasure to mention my sincere thanks to Shri. D. G. Anvikar, Assistant Professor, Dr. R. M. Gade, Professor,

Dr. R. W. Ingle, Associate Professor, Dr. G. K. Giri, Associate Professor, Shri B. N. Ninawe, Assistant Professor, Dr. Ashwini Charpe, Assistant Professor, Dr. S. B. Brahmankar, Assistant Professor, Department of Plant Pathology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, for their kind co-operation, valuable guidance during this study.

I wish to express my sincere thanks to Ph.D. affectionate friends Shri. V. V. Deshmukh, Miss. Sarika Armarkar, Mrs. Manjusha Gaikwad, Meena Koche, Shri. S. S. Shinde and Shri. Y. N. Mohod for their valuable suggestions and comments during my research investigation.

I express my special thanks to my friends Rekha, Nivedita, Swati, Dhyaneshwari, Pratibha, Sonali, Yasho, Priyanka, Isha, Nisha, Trupti, Yogita, Sachin, Ravi, Vishal, Gajanan, Hitesh, Rameshwar, Pramod, Sunil who supported me morally during course of investigation.

Words are not enough to express my gratitude, love and affection to my father, Shri. Chintamanrao Shriramji Borekar and my mother Sau. Manda C. Borekar, My sister Sau. Ashwini Ambekar, my brother Swapnil and all my relatives, who took pains in providing all my needs, invoking divine blessing, guidance and shadowing me by showing their back to sun without which this work would not have seen the light of the day at all.

I am thankful to all authors and researchers, whose articles helped me in organizing my research work on proper line and utilize proper tools for interpretation of the results.

I am fortunate enough to receive the kind co-operation from almost every one in one way or the other, during my stay at this institute. It is extremely difficult to thank all of them individually by name; this short coming may please be pardoned.

Lastly I am very thankful to of Mr. Nikhil Kathiwale (Nikhil Grafix, Akola) for their co-ordination in bringing out the printed script within the stipulated time frame.

Place : Akola.

(Borekar Kirti Chintamanrao)

Date : 31 / 05/2010.

Enrollment No. CC/551

Table of Contents

(A) List of Tables

(B) List of Figures

(C) List of Plates

(D) Abbreviations

%	:	per cent
/	:	Per
°C	:	Degree Celsius
Agri.	:	Agriculture
Agril.	:	Agricultural
CD	:	Critical difference
CD (P = 0.01)	:	Critical Difference at 1 % level
cm	:	centimeter
et al.	:	et alia (and others)
Fig.	:	Figure
g	:	gram
i.e.	:	that is
in vitro	:	In laboratory
J.	:	Journal
Met.	:	Meterological
ml	:	milliliter
mm	:	millimeter
PDI	:	Per cent Disease Intensity
PGI	:	Per cent Growth Inhibition
ppm	:	Parts per million
Res.	:	Research
RH-I	:	Morning relative humidity
RH-II	:	Evening relative humidity
SE(m)±	:	Standard error of mean
sig.	:	Significant
sp.	:	Species
Std.	:	Standard
T max	:	Maximum temperature
T min	:	Minimum temperature
Univ.	:	University
viz.,	:	Namely
W/V	:	Weight by volume

(F) Thesis Abstract

a)	**Title of the thesis**	:	**"CAUSE AND MANAGEMENT OF FUNGAL DISEASES OF SOME MEDICINAL AND AROMATIC PLANTS"**
b)	**Full name of student**	:	**BOREKAR KIRTI CHINTAMANRAO**
c)	**Name and address of Major Advisor**	:	**Dr. S. T. Ingle** Assistant Professor, Plant Pathology Section, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) - 444104.
d)	**Degree to be awarded**	:	M.Sc. (Agriculture)
e)	**Year of award of degree**	:	2010
f)	**Major subject**	:	Plant Pathology
g)	**Total number of pages in the thesis**	:	80
h)	**Number of words in the abstract**	:	460
i)	**Signature of the student**	:	
j)	**Signature, name and address of forwarding authority**	:	

Head
Department of Plant Pathology
Post Graduate Institute,
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.).

ABSTRACT

Medicinal and aromatic plants constitute a group of industrially important crops which are of great value for domestic use and for export. Thus large scale cultivation of these plants came into existence. Commercial cultivation dramatically increased the disease problems in medicinal and aromatic plants. The number of fungal diseases responsible

for affecting growth and productivity, causing economical losses. Therefore the present studies were initiated under the title "Cause and management of fungal diseases of some medicinal and aromatic plants"

Diseased samples of medicinal and aromatic plants were collected from the field of Nagarjun Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and Betelvine Research Station, Diwthana. Among the eighteen medicinal/ aromatic plants grown at Nagarjun Research Unit, Akola were constantly observed for occurance of diseases during Kharif season 2009-10. Nine medicinal and four aromatic plants were found to infected with fungal disease. Kalmegh (*Andrographis paniculata*), Isabgol (*Plantago ovata*), Jesthmadh (*Glycyrrhiza glabra*), Shatavari (*Asparagus racemosus*), Gawati chaha (*cymbopogan flexuosus*) were found to be free from fungal infection. Disease samples of showing disease symptoms were collected and Isolation of disease causing fungi were made by tissue isolation method and their identity and pathogenicity was confirmed.

Proved the pathogenicity of causal pathogen on Ashwagandha (*Withania somnifera*), Safed musli (*Chlorophytum borivilinum*), Lendipimpli (*Piper longum*), Datura (*Datura innoxia*), Coleus (*Coleus forskolii*) Tikhadi (*cymbopogan martinii*) and Pudina (*Mentha arvensis*). The fungi *Alternaria, Colletotrichum, Curvularia* were predominant causing the infection.

Ashwagandha a medicinal crop was found to infect with two diseases i.e. leaf blight caused by *Alternaria* sp. and root rot caused by *Fusarium solani*. Maximum intensity of leaf blight (42.63%) was observed during last week of December. Root rot incidence was initiated during 40th met. week and per cent increase in disease incidence was 24.55% during 49th met. week. Safed musli was found to infect with leaf blight caused by *Colletotrichum dematium*. The higher intensity (40.86%) of leaf blight was observed during last week of November. Leaf spot of Korpad caused by *Phoma* sp. and disease was reached to its peak i.e. 56.67% during 48th met. week.

Among the aromatic plants Tikhadi was found to infected with leaf blight caused by *Curvularia lunata* with the maximum intensity i.e. 44.55% during 3rd week of November. Severe infection of die-back of Pudina was caused by *Colletotrichum lini* and maximum disease intensity (48.90%) was observed in last week of December.

Initiation of almost all fungal disease was observed during July, August with temperature range between 22-30^{0}C and high humidity prevailed during proceeding week. Contributory and profound effect of all weather parameters were found to correlate with disease development.

Among all the botanicals tested *Eucalyptus* sp., *Azadirachta indica, Ipomea carnea* provided high inhibitory effect against tested pathogen while *Nerium oleander, Lantana camera, Pongamea pinnata* showed least efficiency against test pathogen.

CHAPTER I

INTRODUCTION

1.1 Background Information

Long before the development of modern medicines, man in ancient times, was entirely dependent on herbal medicines for health care. India was the leader in health care through Ayurveda. The knowledge about the importance of medicinal plants is being lost because of rapid progress of allopathic medicines and modernization.

Indian system of medicines strengthened over centuries through practice and oral tradition makes use of many medicinal herbs. These include large number of native preparations established in Ayurveda, Siddha, Unani, Chinese, Tibetan, Naturopathy, Aromapathy, Homoeopathy and have recorded curative properties through the ancient writings. (Parihar and Bohra, 2002).

Plant based drugs are being increasingly preferred in medical science. The use of various part of several drug plants to cure specific ailments has been in vogue from ancient times in our indigenous medicine. Among the plant products some of them have good scope economically i.e. essential oil bearing plants, oilseed plants, gums and resins, fruits and nuts. The medicinal herbs in the manufacture of herbal drugs is creating a great demand for medicinal plants. Medicinal plants can be further investigated for the active principles and testing is essential for pharmacological and clinical trials and release for safe care as drugs. Medicinal plants can be cultivated commercially for extraction of some important active constituents for use in modern medicine. Thus, such

studies will bring to evolve some new sources of medicine of herbal origin (Khan *et al.*, 2002).

India has been considered a treasure house of valuable medicinal and aromatic plant species. These plants can be cultivated under diversified geographical environmental condition. To fulfil increasing demand of the people commercial cultivation increases. But now a days the diseases have been noticed to tremendously reduce the yield of medicinal and aromatic plants.

1.2 Importance and Need of the Study

Medicinal and aromatic plants constitute a major segment of the flora, which provides raw materials for use in the pharmaceuticals, cosmetics and drug industries. As compared to the traditional crops, the cultivation of medicinal crops has many advantages such as medicinal crops provides better return than traditional crops, have very high domestic and export demand, fetch better prices in the market, could be stored for a long time, require minimum resources, therefore the cost of cultivation is lower as compared to, the traditional crops. On account of the fact that derivations of medicinal and aromatic plants have no side effects and deal curatively, the demand for these plants is on the increase in both developing and developed countries. As a result, the trade of medicinal plants is increasing fast.

Medicinal plants are those plants rich in secondary metabolites and are potential source of drugs, includes alkaloids, glycosides, coumarins, flavonoids, steroids etc.

India has about 2000 species of medicinal plants on a vast geographical area with high production potential. Medicinal plants offers considerable scope for rural employment and foreign exchange.

Aromatic plants are those plants which possesses essential oil in them. These essential oil are used in perfumery cosmetic and pharmaceutical industries. The essential oil accumulation in plant depends upon the developmental stage of the concerned organ / plant part. Use of aromatic plants and plant products is an old as our history. India is earning a foreign exchange of Rupee around 85 crores (1991-92) per annum by way of export of aromatic essential oil (Kumar, 1997).

Among the medicinal and aromatic plants Safed musli, Lemon grass, *Ocimum sanctum,* Coleus, *Piper longum. Mentha arvensis,* Ashwagandha and *Aloe vera* etc. were mainly proned with the pathogen causing severe losses in yield. In general, pathogens are responsible for causing the diseases through soil are *Rhizoctonia bataticola, R. solani, Fusarium solani, Sclerotium rolfsii, Phythium* etc. The predominant foliar pathogens are *Colletotrichum, Curvularia lunata, Alternaria* sp. causing leaf blight, leaf spot by *Phoma* sp. in various medicinal plants. These pathogen cause damage to the crop result in severe reduction in yield and deterioration of phytochemical constituents i.e. medicinal values. Therefore there is need to study for managed these pathogens by using different plant proctectant.

1.3 Objectives of Study

In view of above specific problems of medicinal and aromatic plants, regarding the attack of fungal pathogens, it is felt necessary to undertake the study with following objectives.

1) To acertain the association of pathogen causing foliar fungal diseases of medicinal and aromatic plants.
2) Seasonal incidence of major diseases.
3) Management of fungal diseases causing pathogen with botanicals (*in vitro*).

1.4 Hypothesis

The fact that derivatives of medicinal and aromatic plants are non-narcotic have no ill effects and constitute the natural base for treatments have resulted in an increase in demand for these plants in developing and non developed countries. Due to this rising international demand, many important medicinal plant species are becoming scarce and some are facing the prospect of extinction. Therefore, it is important to conserve the extensively traded medicinal plants in its environments. However, due to increase in area there will be pathological problem and the plant may succumb to diseases which are detrimental for increase in production as well as qualitative reduction in phytochemical content.

Therefore, the attempts are required to investigate the pathological problem in regard to occurrence of major diseases, its causal pathogen with some remedial measures to minimize the disease.

1.5 Scope and limitations

Since 'Ayurveda' and 'Charak Sahita' are becoming popular for combating the diseases without hazardous effects to living being. The trade in medicinal plants has increased, both in the form of raw material, as well as processed medicines. Hence cultivation of medicinal and aromatic plant will increase in ensuring future. Due to mass cultivation / production marketing facilities may also develop which would be suitable for cultivers. Medicinal and aromatic crops have better economic opportunities as against the traditional field crops. There is now wide recognition of the contributions that medicinal and aromatic plants make the global economy and human welfare.

With the advancement of knowledge during the era of IT (Information Technology) and BT (Biotechnology) the importance of plant source drugs is decreasing to certain extent in modern medicines due to synthetic drugs and antibiotics. Medicinal plants are affected by large number of pathogen and affect the quality. Thus these diseases are directly related to the manufacture of plant products, phytochemical and pharmaceuticals.

Hence, the present investigation is done on the 'Cause and Management of fungal diseases of some medicinal and aromatic plants'.

CHAPTER II

REVIEW OF LITERATURE

Investigation regarding "Cause and management of fungal diseases of medicinal and aromatic plants" was undertaken and attempts have been made to putforth the recently published review under the following major heads.

2.1 Isolation, Pathogenicity and Symptoms

Ganguly and Pandotra (1962[a]) observed the leaf spot on leaves of *Datura stramonium, D. metel* and *D. innoxia.* The infection caused severe defoliation resulted in considerable economic losses. Spots were dark brown round to oval or slightly irregular, coalescing and forming large necrotic areas. The causal organism was reported *Alternaria tenuissima.*

Ganguly and Pandotra (1962[b]) reported the leaf blight and bud rot of *Rauvolfia serpentina*. The symptoms appeared as initially in the form of small brown circular spots with yellowish margin on the ventral surface of the leaves. These spots enlarged forming dark brown circular lesion. The causal organism was *Alternaria tenuis.*

Janardhanan *et al.* (1964) observed the wilt disease of *Rauvolfia serpentina* caused by *Fusarium oxysporum.* Initial symptoms of the disease consist of wilting of branches and entire plant. Coller region and the root portion below the ground level also turned into dark colour.

Varadarajan (1966) observed the leaf spot disease of *Rauvolfia serpentina* caused by *Curvularia lunata*. The symptoms consist of severe leaf spots and defoliation.

Shreemali (1972) during regular survey of Jodhpur and its surroundings, observed that the twigs of *Boerhavia doffusa* linn and *Adhatoda Vasica* Nees were severely infected during month of Sept. to Nov, the symptoms were recorded and isolations made from the diseased portion. The organisms were identified as the species of *Phoma*. Pathogenicity test were made on respective plants.

Khan and Abdel Karer (1974) reported that the leaf blight disease on *Glycyrrhiza glabra* caused by *Alternaria alternata*. Symptoms consist of light brown to black spots on the leaves and stem. In the late stage of the season the spots coalesced resulting in blight symptoms.

Thakur *et al.* (1974) observed a new leaf spot disease on Japanese mint *(Mentha arvensis)* during the months of May to late September, 1973 in experimental plantation of Regional Research Laboratory, Jammu. The initial symptoms of the disease appear as very minute spots less than one mm. These spots increase in their size to form big spherical or irregular spots. In the advanced stages they coalesce and form large dark brown patches of irregular size. The infected leaf become chlorotic and finally withers away. The fungus was identified as *Curvularia lunata*. The pathogenicity was established by spray of the spore collected from 7 days old culture.

Roy (1976) recorded several fungi associated with various leaf spot diseases of medicinal plants common at Bhagalpur and its suburbs. The causal organism of leaf spot of *Aloe vera* was *Fusarium solani, Pestalotiopsis versicolour, Phoma sorghina, Phomopsis aloespercrassae, Colletotrichum gloeosporioides*. The isolation of infected part of Datura metel yielded *Curvularia verruculosa, Drechslera, Adhatoda vasica, Alternaria alternata, Chaetomium globosum, Colletotrichum capsici, Botryodiplodia theobromae* etc

Chauhan and Singh (1977) observed that *Rhizoctonia solani* attacks the lemon grass (*Cymbopogan flexuosus*). The initial symptom of the disease appeared as distinct large, oblong or irregularly elongated spots distributed on the lamina. These spot measured 1- 2.5 cm in the beginning. The spot were greenish grey later become pale straw in colour with definite radish brown border. The pathogenecity of the fungus was established.

Sharma (1978) reported the collar rot and leaf blight of *Occimum* in the form of brown soft spots at the collar region of the plant which latter girdled whole of the stem. Such plant topples down and died. The fungus associated with collar rot and leaf blight identified as *Rhizoctonia solani.*

Alam *et al.* (1979) observed a severe leaf spot disease on *Cymbopogan pendulus.* The initial symptoms of the disease appear as small circular to ovoid, light brown spots on the leaf blades. The spot enlarges in later stage measure up to 20 x 1.5 mm in size in advanced stage of infection, the spot coalesced together and cause premature death and drying of the leaves. The isolations yielded a species of *Curvularia.* And the pathogen was identified as *Curvularia trifolii.* The pathogenecity was also proved.

Chastager *et al.* (1979) observed that *Plantago ovata* suffers from both pre-emergence and post emergence damping off. Initial infection appered as darkened water soaked spots on coller region of the seedlings. The infection extends rapidly leading to the death of seedlings causal organism of damping off of *Plantago ovata* was *Pythium ultimum* and *Rhizoctonia solani.*

Goyal and Pathak (1982) observed the leaf blight of *Catharanthus roseus* in Lucknow caused by *Alternaria alternata.* The

severity of disease increased in the rainy season. The symptoms of the disease appeared as small light brown spots involving almost whole of the surface of the leaf. The lesion later becomes necrotic with concentric rings.

Pillai and Patel (1982) reported the leaf blight disease of senna (*Cassia angustifolia)* caused by *Alternaria alternata*. Initial symptoms were minute dark brown circular spots on the lamina especially at the tip and margin of leaflets. The spots enlarged upto 3.8 cm turned brown to black in colour and became irregular.

Barua and Bordoloi (1983) observed the leaf spot disease on lemon grass (*Cymbopogan flexusus*) during September 1978. The disease was recognized initially as small pink coloured circular spot on the leaf surface and as the disease advanced the pink coloured spot turned brown enlarged and spread to form brown patches. The fungus was isolated from the infected lesions on potato dextrose agar (PDA) medium and identified as *Curvularia verruciformis*.

Patel and Patel (1984) stated that the damping off was the most devastating disease of the *Cassia angustifolia*. The infected plant showed blackening on the collar region extending upwords leading to death of plants in patches in the field and the causal organism was *Macrophomina phaseolina*.

Pandey and Nigam (1985) observed the dieback and leaf blight disease of Ashwagandha crop. It is caused by *Alternaria alternata*. The symptoms of the disease with the appearance of small light brown spot on leaves and flowers. Spots coalesced resulted in blight symptoms. In case of the dieback the disease caused necrosis of tender twigs from the tip backwards.

Sathyarajan and Naseema (1985) observed the leaf spot disease of *Piper longum* caused by *Colletotrichum gloeosporioides*. The

pathogenicity was established by spray of the spore collected from 10 days old culture.

Kodmelwar and Shukla (1986) proved the pathogenicity of *Colletotrichum curcumae* causing leaf blotch disease of *Curcuma longa*. *C. curcumae* was reported for the first time on petioles and inflorescence.

Damicone and Manning (1987) observed the asparagus (*Asparagus officinalis*) stem and crown rot, caused by *Fusarium moniliforme* and wilt / root rot caused by *Fusarium oxysporum*.

Naik et al (1987) reported that none of the piper betle garden in seven districts of Karnataka was free from the disease caused by *Colletotrichum gloeosporioides* with an incidence of 11-19 percent.

Naik *et al.* (1990) noticed incidence of infection by *Colletotrichum gloeosporioides* on *Piper betel* was highest in August (disease index 44 %), followed by September (43%) and July (32%) and lowest in April (2%). Disease development may have been favoured by the continuous rainfall between January and September. The low disease index during early summer was associated with low RH and high temp.

Kuch (1990) reported the important disease of *Piper longum* with respect to its distribution, symptomatology, etiology, epidemiology damage and control. The aerial parts were infected resulting in blackening of berry caused by *Colletotrichum capsici* and *C. gloeosporioides*.

Sato and Ohkubo (1990) discovered leaf blight of citronella grass caused by *curvularia andropogonis* in the Philippines. Symptoms of the disease, morphology, isolation, physiologic characters and identification of pathogen causing leaf blight of *Cymbopogan nardus* have been reported.

Renubala and Dutta (1991) reported that *C. capsici* occurred on *Piper betel* Jorhat through the year (1986) in varying degrees of severity. Disease incidence, disease intensity and coefficient of disease intensity were maximum from May to August 1986, coupled with heavy rainfall and high relative humidity.

Naseema and Wilson (1991) recorded *Curvularia, Botrydiplodia theobromae, Fusarium pallidoroseum* and *Alternaria alternata* on *Artemisia nilagirica, Coleus vetiveroides, Justicia gendarussa* and *Kalanchoe laciniata,* respectively in India. Disease symptoms were also described.

Rai (1992) recorded the leaf spot disease of chitrak (*Plumbago zeylanica)* caused by *Phoma exigua.* The disease incidence was more on lower leaves in comparison to the leaves of apical portion. The disease started on the margin of the leaf blade producing pinhead like dots. The spots coalesced form diffused irregular structure with ashy grey brownish zonation finally forming shot holes. The pathogenicity of the fungus was confirmed by spraying the spore suspension prepared in sterile water on the foliage of four months old plants.

Paul and Bhardwaj (1992) observed the leaf blight on *Glycyrrhiza glabra* caused by *Phyllosticta glycyrrhizae.* Initial symptoms consist of pin head size dark brown spots. The spots later developed into circular to irregular shapes of 2-3 mm size on both surface of leaves. The lesion were dark brown in the centre surrounded by light brown margins.

Singh (1993) observed a serious leaf spot disease of *Curcuma zedoaria* from Jabalpur during August 1991. Incidence of disease was moderate and almost every leaf in plant was attacked. The causal fungus was identified as *Colletotrichum capsici.* The disease appeared soon after the rains. Dull pale, pin head spots were scattered all over the

lamina, quite often spots coalesced to form larger lesions. Severely infected leaves turned yellow and shed prematurely.

Shukla *et al.* (1993) reported the leaf blight of *Coleus forskolii* caused by *Rhizoctonia solani*. Symptoms consist of water soaked leaf spots, increased rapidly in size and became light and turned to brown in colour. The spots coalesced resulting in blight symptoms. Severe infection caused death of the plants.

Holcomb and Reed (1994) reported the wilt of basil (*Ocimum basilicum*) caused by *Sclerotinia sclerotiorum*. The symptoms consist of brown longitudinal discoloration of the stem with dark brown to purple coloured margins.

Patil (1995) reported the severity of root rot in vetiver from different localities of Akola district. Per cent dead hearts were 0-100 per cent in different types of soil. The studies on nutritional aspects were made and stated that *sclerotia* could survive for more than 9 month in soil.

Singh *et al.* (1996) reported a new leaf blight disease affecting *Cassia angustifolia* caused by *Alternaria cassia*. The symptoms consist of small, pale to dark brown spots. The lesions first appeared on the tips and margins of leaflets and later coalesced leading to complete necrosis of leaves. The disease caused blighted appearance with dark irregular spots on the stem and pods.

Gupta *et al.* (1997) reported the leaf spot disease of *Cassia angustifolia* from experimental plantation in Lucknow. Initial symptoms appeared as small pinhead brown to dark brown spots on the leaf lamina. The spots enlarged towards the margins resulting in death and defoliation. The causal organism was reported as *Colletotrichum gloeosporioides*.

Devi and singh (1999) observed severe anthracnose of chilli causing 80 per cent seedling mortality. Symptoms of the disease were

described. The causal agent was identified as *Colletotrichum gloeosporioides (Glomerella cingulata)* and its pathogenicity was confirmed.

Koike and Molinar (1999) observed the rust disease of lemongrass (*Cympogan citrates*). Symptoms of rust disease causing elongated stripe like, dark brown lesions on both sides of leaf surfaces have been described. Based on the morphology of the *uredinia and urediniospore*, the causal organism has been identified as *Puccinia nakanishikii.*

Shukla *et al.* (2001) observed the root rot on mint (*Mentha arvensis*). The initial symptoms of the diseases appeared as black dots on the stem internodes which later extend upwards. The blackening of stem branches and leaves midrib along with veins spread longitudinally to the entire plants and caused tissue necrosis. The disease was particularly severe during April to June. Pathogenicity of *Botryodipdia theabromae* was established in *Mentha arvensis.*

Mandal and Geetha (2001) reported downey mildew of isabgol *(Plantago ovata*). The *Peronospora plantaginis* under wood infected spikes were marked and symptoms were recorded at different stages of development.

Monteiro and Barreto (2002) reported that *Curvularia andropogonis* was the causal agent of a foliage blight of lemongrass (*Cymbopogan citrates).*

Rakholiya *et al.* (2003) observed whitish fungal on roots of Isabgol (*Plantago ovata*) in Gujrat during October to December. The causal organism was identified as *(Sclerotium rolfsii*) and its pathogenecity was confirmed.

Alam (2004) noticed the *Colletotrichum* blight with disease intensity ranges from 12 to 32.4 per cent in *Piper longum* having incidence on berries up to 1.70 to 16.60 per cent.

Mandal *et al.* (2004) recorded the eye spots near the mid rib of lamina on safed musli (*Chlorophytum borivilianum*). It remained small (3x2mm) with thick dark brown margin and whitish centre. The centre often got detached and produced shot hole symptom. Elongated spot with dark brown margin and light brown or ash coloured centre were appeared and the fungus was identified as *Macrophomina phaseolina*. They also reported the pathogen *Colletotrichum chlorophytum* causing leaf spot in musli.

Pandey (2005) recorded the occurance of root rot and wilt on safed musli *(Chlorophytum borovilianum*) in farmer's field in Madhya Pradesh. The initial symptoms were yellowing and withering of leaves starting from the lower most leaves. Isolation from the affected root yielded *Fusarium solani* and pathogeniecity was confirmed.

Bhave (2005) confirmed the pathogenicity of *Colletotrichum gloeosporioides* on black pepper. The symptoms on inoculated seedlings with mycelial bits were observed 5 days after inoculation.

Kumar *et al.* (2005) observed the fungal diversity of the rhizosphere of some medicinal plants of Western Rajasthan viz., *Adhatoda vasica, Asparagus vesia, A. racimosus, Commiphora wightii, Plantago ovata, Withania somnifera*. Among the mycoflora isolated from these plant, five species of *Aspergillus* were dominant in rhizosphere of all the plants. The *Curvularia, Fusarium, Penicillium Rhizopus* and *Trichoderma* and one species of each of *Drechslera, Chaetomium, Trichothecium, Cladosporium, Macrophomina, Rhizoctonia* and *Mucor.*

Jamaluddin (2005) recorded number of important disease responsible for affecting growth and productivity causing economical loss.

There are some serious diseases which affect the productivity of medicinal plant viz., aonla, neem, safed musli (*Chlorophytum borivilianum*), bursera, *Rauvolfia serpentina* and *Aloe-vera* etc. Forest nurseries and plantation in central India found to infect with serious diseases.

Lakpale *et al.* (2005) stated that the medicinal plants were infected with different disease causing agents. The diseases were leaf blight, leaf spot and root rot. The per cent disease severity was recorded for each disease and the causal organisms were identified as *Curvularia andropogonis* causing leaf blight, while leaf spot of palmorosa caused by *Colletotrichum caudatum*.

Gupta *et al.* (2006) observed Symptoms of root rot and wilt in the fields of ashwagandha (*W. somnifera*) in Lucknow (Uttar Pradesh, India). Initial symptoms were withering and drooping of the plants while at later stages, plants showed severe wilting leading to death and decay of underground parts. The root of infected plant showed pulpiness with brownish colour. White cottony growth of the fungus was observed at the basal part of infected plants near ground level. The plants in the nurseries also showed symptoms of yellowing, drooping and decay at seedling stage leading to 30-50per cent mortality. Further investigations to characterize the infecting fungus led to identification of *F. solani* as the causative organism

Sattar *et al.* (2006) observed Safed musli (*Chlorophytum borivilianum*) in Lucknow, Pantnagar and adjoining areas in northern India was severely affected by a leaf blight disease. Initial symptoms were the appearance of minute, pin-head, circular, reddish-brown lesions on the leaves, which form longitudinal streaks along the midrib, veins and margin of the infected leaves. Severely infected leaves dry prematurely and plants fail to produce healthy fingers (tubers) used for medicinal purposes. The

disease occurred in August and September. Isolations from the young and mature necrotic lesions invariably yielded a *Colletotrichum* species. Based on these morphological features the fungus was identified as *Colletotrichum capsici* and pathogenicity was also proved.

Ahir *et al.* (2006) observed the Safed musli grown on cultivators field was found to suffer from a root disease. Pathogenicity of the *Fusarium solani* on potted plant was proved.

Singh *et al.* (2006[a]) reported the leaf blight of *Argyreia nervosa* and leaf spot of *Thespesia populnea*. The leaf blight of *A. nervosa* was caused by *Alternaria citri* and leaf spot of *T. populnea* was caused by *Alternaria alternata*

Singh *et al.* (2006[b]) studied the symptomology of the disease caused by *Alternaria alternata* on *Adhatoda vasica* under natural condition.. The fungus was confirmed from infected leaves and inflorescence of *A. Vasica*. The intensity grades were developed using disease assessment key as healthy, 1= upto 10; 2= >2 10 to 25; 3= > 25 to 50; 4 = > 50 to 70 and 5 = > 75 per cent leaf area infected with the disease. The disease was initiated in the form of small light dark brown lesions surrounded by yellow margins on the leaf blade. The disease also started from margin or tip of the leaf and extended towards inner sides. The average disease intensity in Jaipur district was 24 per cent, whereas in Sikar district 21 per cent.

Maharshi (2006) observed that *Fusarium solani* and *Rhizoctonia bataticola (Macrophomina phaseolina)* causing seedling mortality and later manifesting wilt/root rot syndrome in Ashwagandha (*Withania somnifera*).

Gupta *et al.* (2007) observed some medicinal plants in Madhya Pradesh, India infected by different fungi. Among the observations

were: *Colletotrichum gloeosporides* on *Ipomea obscura; Colletotrichum caudatum* on *Cymbopogan martinii; Colletotrichum chlorophytumie* on *Chlorophytum borivillianum; Colletotrichum dematium* on *Acorus calamus* and *Jatropha curcas; Macrophoma sp.* on *Croton tiglium, Pestalotiopsis dicheta* on *Madhuca indica; Pestalotiopsis versicolor* on *Buchanania lanzan; Phoma sp.* on *Terminalia belerica* and *Toria* sp. on *Callicapa macrophylla.*

Karla *et al.* (2007) observed symptoms of severe leaf blight on rosemary (*Rosmarinus officinalis)* at Bangalore, India and the disease caused by *Rhizoctonia solani.*

Maiti *et al.* (2007) observed leaf blight disease of *Withania somnifera* during March in various districts of South Bengal, India. At the initial stages of infection, symptoms appear as small, light brown spots, gradually becoming irregular, dark brown, concentrically zonate with a diffuse margin, frequently surrounded by light yellow haloes. Conspicuous brownish concentric rings in the advanced stage of infection. A species of *Alternaria* was isolated and confirmed as *Alternaria dianthicola* on the basis of morphology. Pathogenicity test was also carried out.

Verma *et al.* (2007) observed that the Safed musli (*Chlorophytum borivilianum)* was infected with leaf spot caused by *Alternaria alternata.* The fungus attacks only leaves of the plant. Initially the lesions were minute with light brown punctuation. The spots were mostly light brown but some were dark brown to black, older lesions were circular to irregular with a diameter of 3-10 mm.

Rashmi Dubey and Pandey (2007) observed severe rust disease of *(Aloe barbadensis*) in the form of several minute dark brown pustules on leaves during winter season. The infection resulted in a

significant reduction in leaf area harvested for the purpose of gel extraction and thus caused a direct economic loss.

Verma and Sharma (2007) observed that the *Fusarium solani* and *Rhizoctonia solani* were associated with the diseased roots of Safed musli. Pathogenicity was established by inoculation of the pathogen grown on corn meal.

Maiti *et al.* (2007) reported *Alternaria alternata* causing leaf spot and leaf blight of some cultivated medicinal plants. This pathogen was widely distributed in lower Gangetic plains of West Bengal (India). The pathogen was isolated from the infected lesions and confirmed by pathogenecity test. Disease symptoms of new cultivated medicinal plants are discussed.

Majumdar *et al.* (2007) reported three new diseases i.e. root rot, leaf blight and leaf spot caused by *Fusarium solani, Drechslera spicifera, Ascochyta sp.* respectively, on *Aloe barbadensis.*

Sharma and Samota (2007) observed three types of leaf spots and root rot diseases on *Aloe vera*. The leaf spot is caused by *Gilmaniella humicola*, another type of leaf spot was caused by *Nigrospora sphaerica* and third type of leaf spot was caused by *Phoma exigua.* and the root rot was caused by *Fusarium solani.*

Ayodele and Ilondu (2008) investigated the fungi associated with base rot disease of *Aloe vera* in Niger Delta area of Nigeria. Fungi and their per cent frequency were *Aspergillus verocosa* 28.03 per cent, *Fusarium oxysporum* 24.24 per cent, *Plectosphaerella cucumerina* 16.67 per cent, *Mammeria ehinobotryoides* 15.91 per cent and *Torula herbarium* 15.15 per cent. In pathogenicity tests, the fungi isolated produced a variety of symptoms ranging from slowly progressive to rapidly progressive lesions leading to complete disintegration of the leaf bases of *A. vera.*

Singh *et al.* (2008) observed collar rot, a new disease of *Chlorophytum borivilianum*, in experimental farms of the National Botanical Research Institute, Lucknow, India The pathogen has been isolated and identified as *Corticium rolfsii*

Verma *et al.* (2008) reported *Pithomyces chartarum*, the causal agent of a leaf spot, on *Withania somnifera*, in India. The pathogen was isolated and identified based on morphology and pathogenicity test.

Dubey and Pandey (2009) observed foot and root rot, a new disease of *Aloe vera* appeared in a farmhouse near Gwalior after the onset of south west monsoon. The severity of the disease increase of at an alarming rate in August, September and caused premature death and rotting of the infected root region. The causal agent was identified as *Sclerotium rolfsii* sacc. The pathogenecity of the fungus was established by artificial inoculation on healthy plant.

Yashoda Hegde *et al* (2009) reported that wilt of *Coleus forskohlii* was caused by three important soil born pathogens like *Fusarium chlamadosporum, Rhizoctonia bataticola* and *Sclerotium rolfsii.*

2.2 Efficacy of different Botanicals *in vitro*

Bambode and Shukla (1973) assayed thirty six plant extracts for their fungitoxic properties against six phytopathogenic fungi namely *Curvularia lunata, Alternaria tenius, Helminthosporium sativum, Helminthosporium speciferum, Fusarium moniliforme and Rhizoctonia bataticola.* Aqueous and alcoholic extract of *Punica granatum* (fruit rind) and *Plubago zetytanica* (root bark) were found to possess fairly good fungicidal action. Aqueous extract from *Eucalyptus* sp., *Jatropha gossypifolia, Nerium oleander* have shown either moderate or slight indication of inhibition against some of the test fungi. *Lantana camera,*

Pongamia glabra have not been found to posses any inhibitory properly against any of the test fungi. Some other plant extract were also found to show fungitoxicity.

Sheikh *et al.* (1977) were studied antifungal properties of various plants against *Alternaria brassicae, Colletotrichum papayae and Helminthosporium* sp. isolated from the leaves of Cauliflower. The extract of Lawsonia alba, *Datura stramonium* and *Mentha piperita* were most effective against all the three test fungi whereas the extract of *Eucalyptus citriodora, Kigelia pinnata, Lantana camera and Thusa compacta* exhibited no inhibition against any of the test fungi. Maximum inhibition of the mycelial growth of *Colletotrichum papayae* and *Helminthosporium* sp. was observed with the extract of Azadirachta indica.

Bhomick and Verdhan (1981) studied relative effectiveness of leaf extract of medicinal plant on growth, sporulation and spore germination of *Curvularia lunata* manifesting different types of leaf spot diseases. Leaf extract of *Azadirachta indica* mostly successfully inhibited the test fungus in terms of its growth sporulation and spore germination.

Bharad and Khune (1988) reported that leaf extract of *Azadirachta indica* and *Eucalyptus globules* had a antifungal properties at 5 per cent concentration against *Curvularia lunata.*

Shivpuri *et al.* (1997) reported the fungitoxic effect of the neem extract containing a high level of antifungal compound (*azadirachtin).*

Karade and Sawant (1999) tested neem, sadafuli and ghaneri extract at 1, 2, 3, 4, 5 and 10 per cent concentration showed radial mycelial inhibition at higher concentration against *Alternaria alternata.*

Yadav (1986) studied antifungal properties of plant extracts. Neem leaf (*A. indica*) 2 percent and Parthenium leaf (*P. hysterophorus*) 1

per cent reported more than 60 per cent fungal inhibition by poison food technique.

Gomathi and Kannabiran (2000) tested the inhibitory effects aqueous leaf extracts of 23 wild plants against the anthracnose fungi, *Colletotrichum capsici* and *Gloeosporium piperatum* infecting *Capsicum annum*. The leaf extracts of *Solanum torvum*, *Datura metel* and *Prosopis juliflora* were effective in inhibiting the conidial germination and mycelial growth of these fungi.

Kumaran *et al.* (2003) studied fungitoxic effects of root extracts of certain plant species against *Colletotrichum capsici* causing anthracnose in *Capsicum annum*. Extracts of ten species viz., *Abrus precatorius*, *Argemone maxicana*, *Aerva lanata*, *Achyranthus* aspera, *Cardiospermum helicacabum*, *Crotolana juncea*, *Croton bonplandianus*, *Ipomoea carnea*, *Parthenium hysterophorus* and *Rauvolfia tetraphylla* were found to show cent percent inhibition of conidial germination at 24 and 48 hr.

Sinha *et al.* (2004) reported that plant extract of *Azadirachta indica* effective in the management of *Colletotrichum capsici*.

Mahmoud *et al.* (2004) studied the efficacy of *Eucalyptus citriodora Hook, Ipomoea carnea, Cuminum cyminum, Allium sativum and Hyoscyamus muticus* leaf extracts in controlling Botrytis fabae, which causes chocolate spot disease in the faba bean. The leaf extracts of *E. citriodora* and *I. carnea* were promising in preference to other extracts for controlling the mycelial growth of *B. fabae*.

Prasad and Barnwal (2004) evaluated leaf extracts of *Azadirachta indica, Pongamia pinnata, Datura metal, Ocimum sanctum, Eucaltptus citriodora and Mentha arvensis,* against *Stemphylium* blight of

onion.In *in vivo* evaluation, 20 per cent leaf extract of *A. indica* recorded lowest disease intensities followed by *D. metal*

Kishore and Pande (2005) evaluated extracts of 38 plant spp. against late leaf spot (LLS, *Phaeoisariopsis personata*) and rust (*Puccinia arachidis*) of groundnut (*Arachis hypogaea*. Among these extracts aqueous leaf extracts (20 per cent, w/v) of *Prosopis juliflora* and *Lycopersicon esculentum* completely inhibited the *in vitro* germination of *P. personata* and *P. arachidis*, and extracts of *Achras sapota*, *Cyamposis tetragonolobus*, *Piper betle* and *Tagetus patula* were inhibitory by >95%.

Patni *et al.* (2005) tested the methanol extract of six medicinal plants against *Alternaria* blight of mustard. Among these extracts Eucalyptus, Ashoka and *Calotropis* extracts, in that order, were promising in limiting the growth and sporulation of the pathogen, whereas *Parthenium* extracts promoted these.

Mandvi Singh and Singh (2005) tested antifungal activities of leaf extracts of 26 angiospermic plants against the pathogenic fungi *Mycogone perniciosa*, *Verticillium fungicola* and *Fusarium moniliforme* causing wet bubble, dry bubble and wilt diseases in white button mushroom. Leaf extracts from the *Aegle marmelos, Berberis aristata, Cannabis sativa, Cleome viscose, Erigeron karvinskianus and Leonotis nepetaefolia* were found effective against tested pathogenic fungi. Among them *Erigeron karvinskianus* was highly effective against all the three pathogen.

Khanzada *et al.* (2006) tested aqueous plant leaf extracts of *Calotropis procera* (Wild.) R.Br. *Cannabis sativa* (L.) and *Datura alba* Nees. @ 0.5, 1.0, 1.5 and 2.0 per cent on the mycelial growth of *Sclerotium rolfsii* Sacc. were evaluated by poisoned food technique. The fungus was grown on chickpea seed meal agar medium (CSMA) for bioassay. *D. alba* and *C.*

procera were found effective @ 1.5 and 2 per cent followed by *C. sativus* (2 per cent) in reducing the mycelial growth of the fungus over the non amended control. In case of sclerotial production, the leaf extracts of *D. alba* and *C. procera* at the concentration of 2%.

Verma and Kharwar (2006) studied the efficacy and in vitro activity of leaf extract of neem (*Azadirachta indica* A. Juss.) on an endophytic fungus *Curvularia lunata*, isolated from neem leaf. It was observed in all concentration variants that during transition of second to third day there is significant increase in percentage inhibition of mycelial growth. Viz. AzPDA 20 by 6.7%, AzPDA 40 by 6.4%, AzPDA 60 by 1.5%. Comparative analysis of all concentration variants however shows handsome net percentage inhibition, it was AzPDA 100 shows maximum 56.1% net percentage mycelial growth inhibition, while AzPDA 20 shows the least 35.4% net percentage inhibition.

Maiti *et al.* (2007) observed leaf blight disease of *Withania somnifera* during March in various districts of South Bengal, India. At the initial stages of infection, symptoms appear as small, light brown spots, concentrically zonate with a diffuse margin, frequently surrounded by light yellow haloes. Conspicuous brownish concentric rings in the advanced stage of infection A species of *Alternaria* was isolated and confirmed as *Alternaria dianthicola* on the basis of morphology. Pathogenicity test was also carried out.

Karande *et al.* (2007) studied the efficacy of seven plant extracts on mycelial growth of *C. gloeosporioides in vitro*. Among these plant extracts, leaf extracts of tulsi 10 per cent (63.8%), sadafuli 10 per cent (57.1%) were quite effective in controlling *C. gloeosporioides*, followed by bougainvillea (45.2%), onion (32.2%), neem (29.6%) and glyricidia (26.0%) showed moderate effect on the fungal growth.

Yadav and Gour (2007) observed reduction in disease index of leaf stripe of barley caused by *Drechslera graminea*, when botanicals (*Lantana camera* and *Azadirachta indica*) were used as seed treatments and foliar sprays both in pot and field experiments. The results showed that *A. indica* and *L. camera* extracts (5%) controlled barley leaf stripe for 55 to 59%.

Jat *et al.* (2008) stated that efficacy of phytoextracts with ethanol and acetone were more inhibitory than water extracts to fruit rot pathogen-*Colletotrichum gloeosporioides*. Extracts from medicinal plants like *Azadirachta indica*, *Tagetes erecta* and *Annona squamosa* were effective in inhibiting the growth of the fungus *in vitro*.

Joseph *et al.* (2008) studied the *in vitro* efficacy of different plant extracts viz., *Azadirachta indica*, *Artemessia annua*, *Eucalyptus globulus*, *Ocimum sanctum* and *Rheum emodi* to control brinjal wilt pathogen (*Fusarium solani*). Different concentrations 5, 10, 15 and 20% of plant extracts was used in the study. All the plant extracts showed significant reduction in the growth of pathogen. Among the different plant extracts 20% of *Azadirachta indica* was found most effective followed by *Rheum emodi*, *Eucalyptus globules*, *Artemessia annua*, and *Ocimum sanctum*.

Lakpale *et al.* (2008) evaluated aqueous extract of different plant species in vitro against important plant pathogens. Extracts of *Datura metal*, *Azadirachta indica*, *Ocimum gratissimum*, *C. domestica*, *Lantana camera*, *Parthenium sp.* and *Solanum nigrum* were found effective in reducing the mycelial growth and spore germination of *Alternaria alternata*, *Fusarium oxysporum*, *F. udum*, *Acrocylindrium oryzae*, *Helminthosporium sativum*, *Phomopsis vexans*, *Botrytis cinerea* and *Rhizopus* sp. Extract of *A. indica*, *Parthenium* sp. and *Datura stramonium* were found to inhibit

mycelial growth and sclerotial formation of *Rhizoctina solani, Sclerotium rolfsii* was inhibited by extracts of *O. gratissimum, L. camera, S. nigrum* and *Ipomea carnea.*

Sreelatha and Bagyanarayana (2008) tested the efficacy of botanicals on anamorphic fungi. Among these botanicals *Nerium odorum* inhibited *C. gloeosporioides* in 5 per cent but the growth of all other organisms was enhanced. *Jatropa gossypifolia* could inhibit *C. dematium* in all concentrations but had little effect on other organisms.

Sankararasubramanian *et al.* (2008) tested fifty plant extracts against *Bipolaris oryzae* (*Cochliobolus miyabeanus*), the causal agent of brown spot disease of rice. In vitro studies indicated that two leaf extracts, *Nerium oleander* and *Pithecolobium dulce* exerted the higher percent inhibition to mycelial growth (77.4, 75.1%) and spore germination (80.3, 80.0%) of *B. oryzae*.

Jadhav *et al.* (2008) tested the antifungal activity of seven plant extract viz., *Lantena camera, Glyricidia maculate, Pongamia pinnata, Bougainvillea spectabilis, Holarrhena antidysentrica, Allium sativum* and *Catharantheus roseus* against Leaf spot disease caused by *Colletotrichum gloeosporioides* on Kokum seedlings. These seven plant extracts were found significantly superior over control. Maximum per cent inhibition was achieved due to garlic *(Allium sativum)* extract (10%).

Sumangala *et al.* (2008) studied seven botanicals against *curvularia lunata*, a causal agent of gain discoloration in rice. Among the seven botanical tested, the garlic bulb extract at 10 per cent concentration inhibited the spore germination of *C. lunata* to maximum extent (96.70%) followed by eucalyptus leaf extract (93.45%) but after 24 hour of incubation leaf extract of neem (66.80%), eucalyptus (64.56%) and datura (64.20%) were found to be effective in inhibiting the spore germination compaired to garlic bulb extract (57.22%).

Theerthagiri (2009) tested leaf extracts (10 per cent) of *Abrus precatorius* (Gundumuthu) and *Aegel marmelos* (vilvum) and demonstrated the highest inhibition of spore germination and mycelial growth of *Colletotrichum capsici* and *Alternaria alternata.*

Watve *et al.* (2009) studied relative effectiveness of leaf extract of some plants against sporulation of *Colletotrichum gloeosporiodes*, among the plant extract, maximum inhibition was achieved due to neem leaf extract (78.15%) and was achieved significantly superior over other plant extracts.

Pandya *et al.* (2009) were evaluated seven phytoextract of indigenous plant *in vitro* against *Fusarium solani*, using poisoned food technique. Significantly lower mycelial growth of pathogen was recorded in extract of tulsi and was found superior over the rest. Next best was *acalypha* followed by garlic, *lantana, naffatio, barmasi* and neem.

Raj *et al.* (2009) determined the spraying of plant products, *Allium sativum* (20%), *Datura metel* (60%) *Azadirachata indica* (60%), *Prosopis juliflora* (60%) and *Eucalyptus globules* (60%) extracts and carbendazim (0.1%). Carbendazim recorded the maximum disease incidence of 17.74%. Among the plant products tested, *Allium sativum* recorded minimum disease incidence at 24.07%.

Yadav *et al.* (2009) tested 42 plant extracts against *Colletotrichum falcatum.* Out of 42 plant species of medicinal plants and their parts tested, only seven showed maximum fungitoxic effect against *C. falcatum in vitro* The most active plants inhibiting the mycelial growth of the test fungus more than 60% were *Andrographis paniculata* (95%), *Azadirachta indica* (87%), *Lawsonia inermis* (85%), *Callistemon lanceolatus* (82%), *Acacia nilotica* and *Cissus lanceolatus* (82%), *Acacia nilotica* and *Cissus quadrangularis* (70%), *Melia azadirach* (61%).

Yashoda Hegde *et al.* (2009) tested eighteen plant extracts against *Rhizoctonia bataticola*. Among these plant extracts, *Eupatorium odoratum* showed maximum inhibition of mycelial growth which was significantly superior over all other plant extracts. Next best treatments were *Allium sativum* and *Azadirachta indica*.

Yashoda Hegde *et al.* (2009) evaluated the antifungal activity of nineteen plant extracts against *Fusarium chlamadosporum*. Among these plant extracts *Allium sativum* was found to be effective and significantly superior over all other plant extracts. *Ocimum sanctum* and *Allium cepa* were effective at 10 per cent concentration. *Glyrecidiam, Cassia fistula* and *Tridax sp.* were least effective against *F. chlamadosporum*.

2.3 Correlation of Disease with Weather Parameters

Maiti and Sen (1985) stated that the incidence of foot rot of betelvine was related to the mean minimum temperature (>22°C) the correlation was found with rainfall and leaf rot / leaf spot leaving mean average daily rainfall of 0.6 mm or above accompanied by moderate to high temperature.

Gupta and Sen (1986) studied the intensity of leaf spot of betelvine caused by *Colletotrichum capsici*, and stated that the disease favoured by high temperature, intermittent rainfall and high humidity. The detailed investigation was carried out for determining the role of inoculum level and the role of moisture on disease development.

Jayasekhar and Muthusamy, (2000) studied the influence of weather conditions on incidence of foot rot (*Phytophthora capsici*) of black pepper (*Piper nigrum*). The number of vines wilted due to foot rot incidence and it was positively correlated with rainfall, number of rainy days, relative humidity and negatively correlated with maximum and minimum

temperatures. Disease incidence was highest in November (North East Mansoon).

Deshmukh and Kurundkar (2002) studied the anthracnose (*Glomerella cingulata*) disease intensity on the leaves, branches and fruits of chilli (cv. Parbhani Tejas) grown in rabi season was correlated with fruit yield. A linear relationship was obtained between disease intensity and fruit yield. The disease intensity on the leaves, branches and fruits was negatively and significantly correlated with green fruit yield of chilli.

Goswami *et al.* (2002) determined the influence of temperature, humidity and rainfall on the development of leaf spot disease of betelvine (*Piper betle*) caused by *Colletotrichum capsici* in cultivars Bangla, Bhabna, Chaltabota and Sanchi. The incidence as well as severity of the disease was maximum on Chaltabota followed by Bangla, Bhabna and Sanchi in the month of June and July.

Meenu Gupta and Garg (2002) conducted a field experiment during August and October to determine the effect of humidity, temperature and rainfall on the incidence and severity of fruit rot in chilli caused by *Colletotrichum capsici*. The disease was observed in the second and third weeks of August and peaked in August and September 2002. Fruit rot incidence was significant and positively correlated with cumulative rainfall and was not significantly correlated with the other meterological factors.

Tekade *et al.* (2009) observed the incidence of root rot 9.67 per cent (*Rhizoctonia bataticola*), leaf blight intensity was 18.67 per cent caused by *Colletotrichum dematium* while *Alternaria* leaf blight was 21.00 per cent. Initiation of almost all fungal diseases was observed during July, August coupled with rainfall and high humidity prevailed during proceeding week. Contributory and profound effect of all the weather parameter was found to correlate with disease development.

Yashoda Hegde *et al.* (2009) observed wilt incidence in nursery bed at Sirsi, leading to 80-100 per cent mortality.

CHAPTER III

MATERIAL AND METHODS

The present investigation entitled "Cause and management of fungal diseases of some medicinal and aromatic plants." was carried out during the Kharif season 2009-10 at Nagarjun Research Unit and in the laboratory of Department of Plant Pathology, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Akola is situated in sub tropical region between 22°42'N latitude and 77°02' E longitudes. The altitude of the place is 307.42 m above mean sea level. The climate of Akola is semi arid and characterized by three distinct season viz., hot and dry summer from March to May, warm humid and rainy season from June to October and mild cold winter from November to February. Average annual precipitation on the basis of last fifteen years is 847.30 mm which received almost from south west monsoon during June to October and actual precipitation was 537.6 mm during the year 2009-10. During the period of investigation the mean maximum temperature in hottest month (May) was 42.6°C, whereas, annual mean minimum temperature in the coldest month (January) was 11.04°C.

Fungal diseases of medicinal and aromatic plants causes severe reduction in yield and qualitative losses. The present investigation deals with recording fungal diseases of some medicinal and aromatic plants, seasonal incidence of major diseases and the efficacy of botanicals against major pathogens of medicinal and aromatic plant *in vitro*.

3.1 Material Required

3.1.1 Glasswares

For laboratory study glasswares such as petriplates, slides, cover slips, beakers, conical flasks, test tubes etc. were used. Glasswares were cleaned by washing with detergent and dried.

3.1.2 Equipments

Laboratory equipments viz., hot air oven, incubator, laminar air flow, electronic chemical balance, distillation unit, refrigerator etc. were used.

3.1.3 Sterilization of glasswares, media and water

The media and distilled water were sterilized in autoclave at 1.05 kg/ cm^2 for 15 minutes.

3.1.4 Test botanicals

The different test plants i.e. Neem (*Azadirachta indica*), Karanj (*Pongamia pinnata*), Ghaneri (*Lantana camera*), Nilgiri (*Eucalyptus* sp.), Kanher (*Nerium oleander), Prosopis juliflora*, Chandrajyoti (*Jatropha gossypifolia*), *Ipomea carnea* were collected from the campus of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study their antifungal effect on growth of the test fungi.

3.2 Method adopted

3.2.1 Record of medicinal and aromatic plant diseases under natural field condition

The initiation and development of diseases on medicinal and aromatic plant was recorded and the weekly observations were correlated with weather parameter. The intensity was assessed on the basis of leaf area covered by the diseases and the incidence of root rot was on per cent

plant incidence. Intensity of disease was recorded by selecting five plants for foliar diseases. Incidence of disease was recorded by selecting the plant affected due to the disease from total number of plants in a marked area.

3.2.2 Collection of diseased samples

Infected parts of medicinal and aromatic plants i.e. leaves, stem, root were collected from the field of Nagarjun Research Unit , Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and examined in the laboratory for external symptoms and for isolation of disease causing pathogen. A diseased part of *Piper longum* was collected from Betelvine Research Station, Diwthana.

3.2.3 Method of Observation

Observation on per cent disease incidence and intensity were recorded periodically. Incidence was calculated from number of infected and healthy plants. The per cent disease incidence was calculated by following formula.

$$\text{Percent Disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

For recording the disease intensity under field condition 0 to 9 rating scale (Mayee and Datar, 1986) was used. Five plants randomly selected from each plot were labeled. Two leaves located at bottom, two middle and two top of the plant were selected and categorized as per scale on the basis of percent leaf area covered by the disease.

The average intensity was worked out by using formula.

$$\text{Percent Disease Intensity (PDI)} = \frac{\sum \text{ of all numerical ratings}}{\text{Total number of leaves examined} \times \text{maximum ratings}} \times 100$$

3.3 Seasonal Incidence and Intensity of Disease In Relation to Weather Parameters

The study was undertaken on different medicinal plants i.e. Ashwagandha (*Withania somnifera*), Pudina (*Mentha arvensis*), Tikhadi (*cymbopogan martini),* Safed musli (*Chlorophytum borivilianum*), Korpad (*Alove barbadensis).*

The meteorological data during the course of investigation for the period from June 2009 to December 2009 recorded at Agro Meteorological Observatory along with normal values are presented in Appendix I. The data was compiled to standard weeks and subjected to correlation equation (Panse and Sukhatme, 1967).

3.4 Preparation of Culture Media (Potato Dextrose Agar)

Peeled potato	-	200 g
Dextrose	-	20 g
Agar -Agar	-	20 g
Distilled water	-	1000 ml

Healthy peeled potatoes 200g were cut into pieces and boiled in 500 ml sterilized distilled water in souce pan for 30 min. Extract was strained through muslin cloth and quantity was measured. In remaining 500 ml water 20g agar-agar and 20g dextrose were dissolved by heating. Both were mixed and volume was made upto one litre. The medium was filtered through muslin cloth and poured into conical flask and test tubes, then plugged with non- absorbent cotton and autoclaved at 1.05 kg/ cm^2 for 15 minuts. Autoclaved tubes were kept in slanting poison to obtain slants for maintenance of cultures.

3.5 Isolation of the pathogen

For the isolation of pathogen Potato Dextrose Agar (PDA) medium was used.

Approximately 20 ml autoclaved PDA was poured in each sterilized petridish and allowed to solidify. The diseased parts were cleaned properly. The diseased portion cut into small bits along with the healthy portion with sterilized blade and transferred into sterile petri plates containing 0.1 per cent mercuric chloride solution for surface sterilization. Afterwards these bits were washed thoroughly in sterile water thrice to remove traces of mercuric chloride. Bits were blot dried by keeping them on sterilized filter paper to absorb the excess water. Three bits each were aseptically transferred to an solidified PDA medium in sterile petridish at equal distance and the plates were incubated at room temperature (27^0C $\pm1^0$C) for 7 days to obtain good growth of fungus. All the operations were carried out aseptically. Growth of organism was observed regularly. The fungus observed around the infected bits was transferred on plates. The slides were prepared and examined under research microscope for identification.

3.6 Purification of Pathogen

After identification the fungal culture from diseased specimen was purified by hyphal tip and maintained on PDA slants for further use.

3.6.1 Maintenance of Culture

The fungus was sub-cultured on Potato dextrose agar slants and allowed to grow at 27°C ±1°C for one week. Such slants were preserved in a refrigerator at 5°C and renewed once in two months.

3.6.2 Identification of Pathogen

Identification of pure culture as *Alternaria alternata, Alternaria* sp. *Colletotrichum lini, Rhizoctonia bataticola, Curvularia lunata, Fusarium solani, Fusarium semitectum, Colletotrichum dematium, Phoma* sp., *Sclerotium rolfsii, Colletotrichum gloeosporioides, Chaetomium globosum,*. was made on the basis of morphology.

3.7 Pathogenicity

Healthy plant parts were tested by excised technique against pathogens. For proving the pathogenecity *Alternaria* sp. *Colletotrichum lini, Rhizoctonia bataticola, Curvularia lunata, Alternaria alternata, Sclerotium rolfsii, Colletotrichum dematium* were tested. The healthy plant parts i.e. branches with the healthy leaves were selected and washed them and basal portion was dipped in 2 per cent sucrose solution. Injuries were made on the leaves with carborandom powder. The 7 days old fungal culture was inoculated and the observations were taken for the development of symptoms.

For foot rot /root rot disease the inoculum was incorporated in the pot containing sterilized soil. The inoculum viz., *Rhizoctonia bataticola* and *Sclerotium rolfsii* was multiplied on sorghum grains. The seed planting material were sown and the initiations of symptoms were noted.

The infected leaf spot /root were used for reisolation as per procedure. The cultures obtained were confirmed for growth with original culture from which isolations were made and ultimately leads to prove the pathogenecity.

The leaf extracts were tested for the efficiency *in vitro* against the pathogens by adopting poisoned food technique.

3.8 Management of Pathogens by Poisoned Food Technique

The principle involved in this technique was to make the nutrient medium toxic with a fungitoxicant and allow the test fungi to grow on medium and study the mycelial inhibition in laboratory.

3.8.1 Preparation of extract of botanicals

Sufficient quantity of fresh green leaves of different test plants were collected from campus of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The following method was used for preparation of aqueous extracts as followed by Bambode and Shukla (1973).

Sufficient quantity of selected plant leaves were soaked in mercuric chloride solution (1:1000) ratio for 5 minuts and then thoroughly washed with sterilized distilled water by three washings. Ten grams of leaves were ground in a blender with 10 ml water. This gave 100% concentration of the plant extract (w/v) which was passed through three folds of muslin cloth so as to remove fibrous and suspended material. This filtrate taken as stock solution of crude aqueous extract and stored at 4^0C. Streptocycline (200 ppm) was mixed as per need for controlling growth of bacteria.

This crude aqueous extract was used in the study.

3.8.2 *In vitro* evaluation of botanicals against the pathogen

In sterilized petriplates, 15 ml PDA with one ml of extract was poured. The plates were inoculated at the centre with a 6 mm disc of 7 days old culture of test fungi. PDA without leaf extract served as control and incubated at (28 ±2°C) for 7 days. Reading of the colony diameter were taken on the 7 day in both test and control samples maintained in triplicates.

3.8.3 Recordings observations

Efficacy of botanicals was assayed by poisoned food technique. Per cent inhibition of mycelial growth was calculated by using the following formula (Vincent, 1927).

$$PGI = \frac{C - T}{C} \times 100$$

Where,

I = Percent Growth Inhibition.
C = Growth of the fungus in control (mm).
T = Growth of the fungus in treatment (mm).

CHAPTER IV

RESULTS AND DISCUSSION

The chapter deals with the result obtained after the study of the collected fact along with discussion thereon. The preliminary data obtained during the course of present investigation during 2009-10 regarding the "Cause and management of fungal diseases of some medicinal and aromatic plants" were recorded and analysed in accordance with the study objectives. The findings of the present study have been presented in this chapter.

4.1 Collection of Diseased Sample

Infected samples of medicinal and aromatic plant showing spot, blight, diseased stem, branches and roots were collected from the field of Nagarjun Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and Betelvine Research Station, Diwthana. Among the eighteen medicinal/ aromatic plants grown at Nagarjun Research Unit, Akola were constantly observed for occurance of diseases during Kharif season 2009-10.

Table 1. Different fungal diseases recorded on medicinal / aromatic plants

Sr. No.	Crop	Diseases	Pathogen
	Medicinal Plant (Seasonal)		
1.	Safed Musli (*Chlorophytum borivilianum*)	Leaf blight	*Colletotrichum dematium*
		Root rot	*Rhizoctonia bataticola*
2.	Kalmegh (*Andrographis paniculata*)	No disease	
3.	Isabgol (*Plantago ovata*)	No disease	

4.	Kasturi bhendi (*Abelmoschus moschatus*)	Leaf blight	*Rhizoctonia bataticola*
5.	Datura (*Datura innoxia*)	Leaf spot	*Alternaria alternata*
6.	Jesthmadh (*Glycyrrhiza glabra*)	No disease	
	Perennial		
7.	Korpad (*Alove barbadensis*)	Leaf spot	*Phoma* sp.
		Root rot	*Fusarium semitectum*
8.	Shatavari (*Asparagus racemosus*)	No disease	
9.	Sarpagandha (*Rauvolfia serpentina*)	Leaf blight	*Alternaria alternata*
		Die back	*Colletotrichum dematium*
10.	Lendipimpli (*Piper longum*)	Leaf blight	*Colletotrichum gloeosporioides*
		Leaf spot	*Chaetomium globosum*
11.	Coleus (*Coleus forskolii*)	Leaf blight	*Curvularia lunata*
	Shrubs		
12.	Tulsi (*Ocimam santum*)	Die back	*Colletotrichum dematium*
13.	Ashwagandha (*Withania somnifera*)	Leaf blight	*Alternaria* sp.
		Root rot	*Fusarium solani*
	Aromatic Plants		
14.	Java citronella (*Cymbopogan nardus*)	Leaf blight	*Curvularia lunata*
15.	Gawati chaha (*cymbopogan flexuosus*)	No disease	
16.	Tikhadi (*cymbopogan martinii*)	Leaf blight	*Curvularia lunata*
17.	Pudina (*Mentha arvensis*)	Dia back	*Colletotrichum lini*
18.	Khus (*Vetiveria zizanioides*)	Foot rot/ Root rot	*Sclerotium rolfsii*

4.2 Isolation

Isolation of diseased samples were made on potato dextrose agar and tissue isolation technique was followed to isolate the pathogen from infected plant parts.

4.2.1 Purification and identification

The isolation of infected samples yielded the fungi namely *Alternaria alternata, Alternaria* sp. *Colletotrichum lini, Rhizoctonia bataticola, Curvularia lunata, Fusarium solani, Fusarium semitectum, Colletotrichum dematium, Phoma* sp., *Sclerotium rolfsii, Colletotrichum gloeosporiodes, Chaetomium globosum.* The isolated fungi were purified by using hyphal tip method. Purified cultures of the fungus were maintained on PDA slants for further studies.

4.3 Medicinal Plants

4.3.1 Ashwagandha (*Withania somnifera*)

Ashwagandha a medicinal crop found to infect by foliar disease causing leaf blight and a root rot pathogens causing root rot under natural field condition.

4.3.1.1 Leaf blight (*Alternaria* sp.)

At the initial stages of infection, symptoms appear as small, light brown spots, gradually becoming irregular, dark brown, concentrically zonate with a diffuse margin, frequently surrounded by light yellow haloes. Conspicuous brownish concentric rings in the advanced stage of infection, which enlarged and coalesced resulting in blight symptoms. The leaf blight disease of *Withania somnifera* was caused by *Alternaria* sp. as the fungus was isolated from infected parts and confirmed the identity of the pathogen.

The pathogenicity was proved by inoculating the culture under excised leaf technique. The symptoms were developed within 3 days of inoculation. Similar symptoms was observed under natural condition. On reisolation the same pathogen was observed which leads to confirm the pathogenicity. (Plate 1)

Table 2. Effect of weather parameter on leaf blight (*Alternaria* sp.) of Ashwagandha

Met. Weeks	Dates	Per cent Disease Intensity
37	10-16 Sep.	0.0
38	17-23	18.05
39	24-30	24.44
40	1-7 Oct.	22.34
41	8-14	25.18
42	15-21	26.00
43	22-28	29.30
44	29-4 Nov.	32.62
45	5-11	33.56
46	12-18	33.97
47	19-25	35.25
48	26-2 Dec.	36.30
49	3-9	36.84
50	10-16	37.83
51	17-23	42.22
52	24-31	42.63

Table 2a. Correlation of leaf blight (*Alternaria* sp.) of Ashwagandha with weather parameters

Disease	Per cent	Rainfall (mm)	Temp. (°C) max.	Temp. (°C) min.	RHI Morning (%)	RHII Evening (%)
Leaf blight	Intensity	-0.271	-0.236	-0.850**	-0.232	-0.696**

Date of sowing 24th to 28th Aug

'r' value at 0.01%=0.485
r' value at 0.05%=0.345

Seasonal incidence

The first appearance of leaf blight of Ashwagandha caused due to *Alternaria* sp. was noted in 38th met week with 18.05% intensity. The infection was at increasing trend and the maximum i.e. 42.63% intensity was observed during 52nd met week i.e. 4th week of December. Negative and significant correlation was observed with minimum temperature and relative humidity evening at both level of significance. Rainfall, maximum temperature and relative humidity morning were non significant with leaf blight caused by *Alternaria* sp. (Table 2, 2a) (Fig. 1) Pandey and Nigam (1985) described the leaf blight disease caused by *Alternaria alternata*. Singh et al. (1996), Pillai and Patel (1982) observed the *Alternaria alternata* a causal pathogen for leaf blight. Thus this report correlates the present findings. Maiti *et al.* (2007) observed leaf blight disease of *Withania somnifera*. The pathogenicity was also proved and a species of *Alternaria* was isolated and confirmed the causal pathogen as *Alternaria dianthicola*.

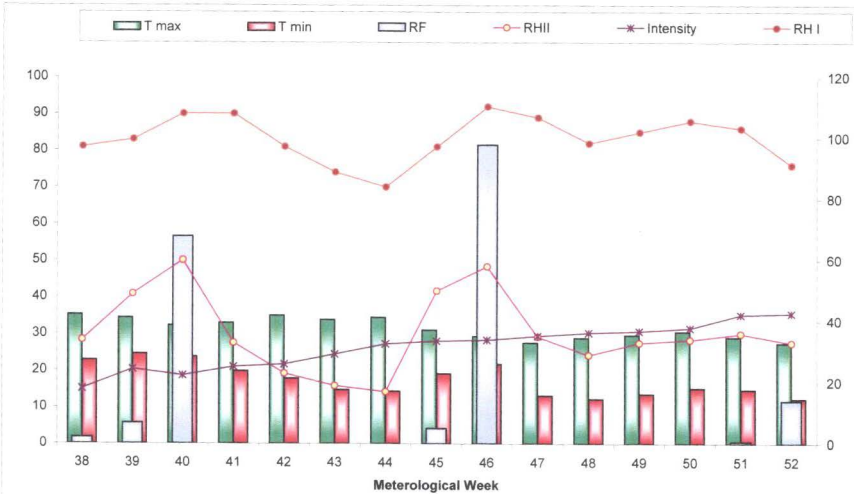


Fig. 1. Effect of weather parameters on leaf blight of Ashwagandha caused by *Alternaria* sp.

Table 3. Efficacy of different botanicals at 5% and 10% concentration against *Alternaria* sp. causing leaf blight of Ashwagandha

Plants extract	Concentration (5%)		Concentration (10%)	
Treatments	Mean colony diameter (mm)	Per cent Growth Inhibition	Mean colony diameter (mm)	Per cent Growth Inhibition
T_1 *Prosofis juliflora*	43.66	49.87	37.10	57.51
T_2 *Azadirachta indica*	29.99	65.57	27.55	68.44
T_3 *Nerium oleander*	54.10	37.89	52.11	40.32
T_4 *Lantana camera*	42.88	50.77	39.77	54.45
T_5 *Eucalyptus* sp.	23.33	73.21	18.55	78.75
T_6 *Jatropha gossypifolia*	26.21	69.91	22.55	74.17
T_7 *Ipomea carnea*	30.22	65.30	22.88	73.79
T_8 *Pongamia pinnata*	54.10	37.89	52.33	40.07
T_9 Control	87.11		87.32	
F test	Sig.		Sig.	
SE(M)	0.34		0.50	
CD(P= 0.01)	1.56		2.29	

Eight plants extract were tested against *Alternaria* sp. for their efficiency and the data are presented in Table 3. There were significant differences in per cent growth inhibition due to botanicals. All the treatments were significantly superior over control at both level of concentration i.e. 5% and 10%.

At 5% concentration *Eucalyptus* sp. showed maximum growth inhibition (73.21%) followed by *Jatropha gossypifolia* (69.91%) and *Azadirachta indica* (65.57%).

At 10% concentration also *Eucalyptus* sp. (18.55 mm) was restrict the growth of the fungi by maximum per cent growth inhibition (78.75%) followed by *Jatropha gossypifolia* (74.17%), *Ipomea carnea* (73.79%) and *Pongamia pinnata* was showed minimum per cent growth inhibition (40.07%). (Plate 2) (Fig. 2)

Healthy

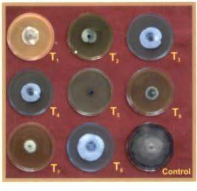
Infected

Leaf blight (*Alternaria* sp.)

Pathogenicity (*Alternaria* sp.)

Spore with mycelium

Plate 1. *Alternaria* sp. causing leaf blight in Ashwagandha (*Withania somnifera*)



10% concentration

Plate 2. Efficacy of different botanicals against *Alternaria* sp.

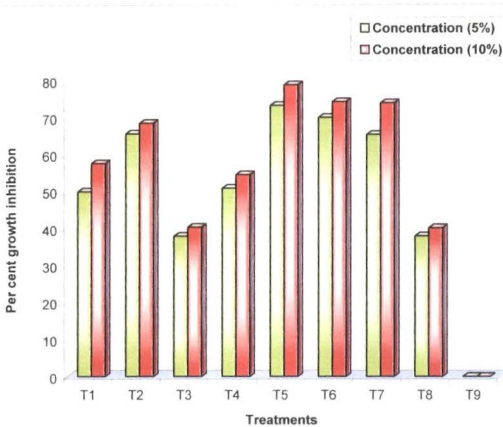


Fig. 2. Efficacy of different botanicals at 5% and 10% concentration against *Alternaria* sp. causing leaf blight of Ashwagandha

T1	-	*Prosofis juliflora*
T2	-	*Azadirachta indica*
T3	-	*Nerium oleander*
T4	-	*Lantana camera*
T5	-	*Eucalyptus* sp.
T6	-	*Jatropha gossypifolia*
T7	-	*Ipomea carnea*
T8	-	*Pongamia pinnata*
T9	-	Control

Table 4a. Correlation of root rot (*Fusarium solani*) of Ashwagandha with weather parameters

Disease	Per cent	Rainfall (mm)	Temp. (°C) max.	Temp. (°C) min.	RHI Morning (%)	RHII Evening (%)
Root rot	Incidence	0.207	0.691**	0.645*	0.003	0.168

Date of sowing 1st of Sept.

'r' value at 0.01% = 0.645
r' value at 0.05% = 0.456

Seasonal incidence

The root rot was initiated during 40th met week when the rainfall was 67.8 mm, max temp 32.2°C, min temp 23.7°C, RH I morning 90% and evening RH II 60%. Maximum disease incidence i.e. 81.00% was observed during 52nd met week. The maximum per cent increase in disease incidence was 24.55% during 3-9 December. Maximum and minimum temperature showed positive and significant correlation with root rot. Rainfall and relative humidity morning and evening showed positive and non significant correlation with the disease. (Table 4, 4a) (Fig 3)

Gupta *et al.* (2006) reported the cause of root rot as *Fusarium solani* in ashwagandha and also reported 30 to 50 per cent mortality at seedlings stage due to root rot fungus. Maharshi (2006) observed that *Fusarium solani* causing seedling mortality and later manifesting wilt/root rot syndrome in Ashwagandha (*W. somnifera*). The present finding corroborates the results.

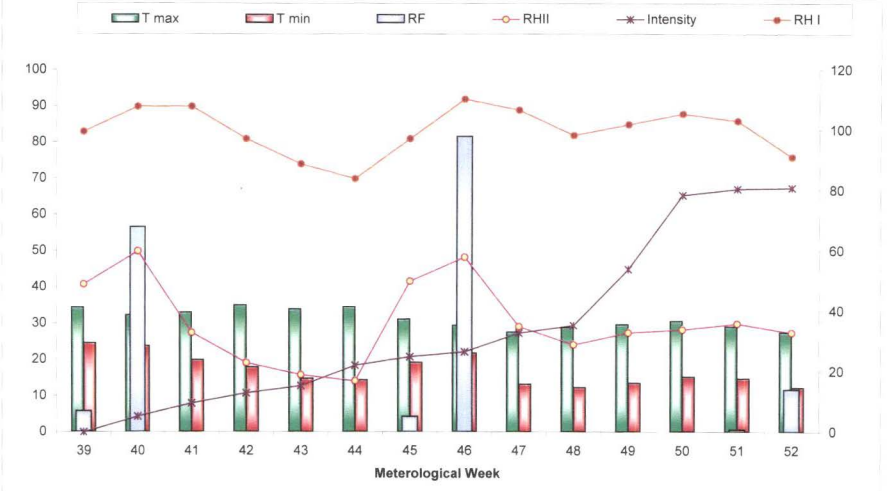
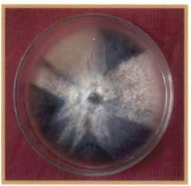


Fig. 3. Effect of weather parameters on root rot of Ashwagandha caused by *Fusarium solani*

Healthy and infected seedling

Growth of *F. solani* on root



Growth of *F. solani* on PDA medium

Macro and Micro conidia of *F. solani*

Plate 3. *Fusarium solani* causing root rot in Ashwagandha

10% concentration

Plate 4. Efficacy of different botanicals against *Fusarium solani*

Table 5. Efficacy of different botanicals at 5% and 10% concentration against *Fusarium solani* causing root rot of Ashwagandha

Plants extract	Concentration (5%)		Concentration (10%)	
Treatments	**Mean colony diameter (mm)**	**Per cent Growth Inhibition**	**Mean colony diameter (mm)**	**Per cent Growth Inhibition**
T_1 *Prosofis juliflora*	37.66	57.19	25.77	71.25
T_2 *Azadirachta indica*	40.55	53.91	37.66	57.99
T_3 *Nerium oleander*	72.66	17.42	67.55	24.65
T_4 *Lantana camera*	51.33	41.66	43.55	51.42
T_5 *Eucalyptus* sp.	54.33	38.25	46.00	48.69
T_6 *Jatropha gossypifolia*	44.77	49.11	37.55	58.11
T_7 *Ipomea carnea*	30.22	65.65	25.88	71.13
T_8 *Pongamia pinnata*	72.55	17.54	48.66	45.72
T_9 Control	87.99		89.66	
F test	Sig.		Sig.	
SE(M)	0.25		0.29	
CD(P= 0.01)	1.14		1.33	

Among the eight plant extracts evaluated against *F. solani* causing root rot of Ashwagandha, *Ipomea carnea* at 5 % concentration showed maximum (65.65%) inhibition of mycelial growth which was significantly superior over all other plants extract. Next best treatments were *Prosofis juliflora* (57.19%) and *Azadirachta indica* (53.91%).

At 10 % concentration, all the treatments were significantly superior over control. *Prosofis juliflora* (25.77 mm) was found to be more effective against *Fusarium solani* followed by *Ipomea carnea* (25.88 mm) and *Azadirachta indica* (37.66 mm) and maximum per cent growth inhibition were 71.25%, 71.13% and 57.99% respectively. The minimum

per cent growth inhibition was recorded in *Nerium oleander* (24.65). Plate 4 (Table 5) (Fig. 4)

Mahmoud *et al.* (2004) observed that the leaf extracts of *ipomea carnea* was promising in preference to other extracts for controlling the mycelial growth of the *Botrytis fabae*. Pandya *et al.* (2009) also evaluated seven phytoextracts of indigenous plant in vitro against *Fusarium solani*, using poisoned food technique and extract of tulsi found effective.

4.3.2 Safed musli (*Chlorophytum borivilianum*)

During the course of investigation Safed musli was found to infect by leaf blight and root rot disease.

4.3.2.1 Leaf blight (*Colletotrichum dematium*)

The initial symptoms consist of the eye shape spots near the mid rib of lamina. The spots were minute, pin-head reddish brown, lesions the leaves, which form longitudinal streaks along the midrib, veins and margin of the infected leaves. At the advanced stage the spots coalesced together resulted in blight symptoms. The infected portion covered with dot like structure i.e. acervuli, consisting setae and large number of spores, under severe condition defoliation was observed.

The isolation of the pathogen was made and the fungus was identified as *Colletotrichum dematium*.

The pathogen was inoculated to the healthy plant and proved the pathogenicity. Three days after inoculation, small water soaked lesions were observed. Later extended to form blightning of the leaves. Reisolation yielded the same pathogen from infected areas. The similar symptoms caused by *Colletotrichum dematium*. Plate 5(a)

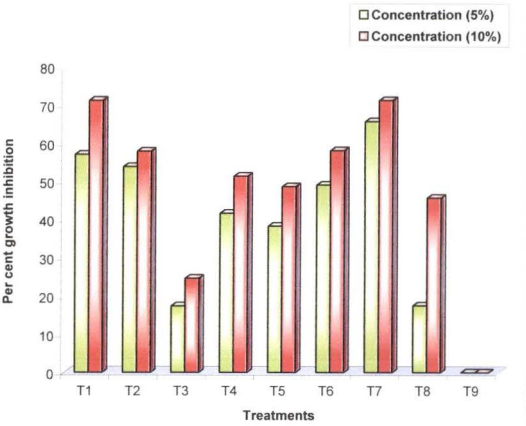


Fig. 4. Efficacy of different botanicals at 5% and 10% concentration against *Fusarium solani* causing root rot of Ashwagandha

T1	-	*Prosofis julif.*
T2	-	*Azadirachta indica*
T3	-	*Nerium oleander*
T4	-	*Lantana camera*
T5	-	*Eucalyptus* sp.
T6	-	*Jatropha gossypifolia*
T7	-	*Ipomea carnea*
T8	-	*Pongamia pinnata*
T9	-	Control

Sattar *et al.* (2006) observed safed musli affected by a leaf blight disease and isolations from young and mature necrotic lesions invariably yielded a *Colletotrichum species.*

Seasonal incidence of blight

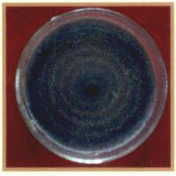
Safed musli a medicinal crop was found to infect with leaf blight caused by fungus *Colletotrichum dematium.* The crop was planted during 4th week of June 2009. The initiation of the disease occure during 34th met. week. When rainfall was 65.7 mm, maximum temperature 31.1°C, minimum temperature 22.8°C, morning RH I 94% and evening RH II 73%. The higher intensity was observed during 4th week of November i.e. 47th met. week and it was 40.86%. (Table 6, 6a) (Fig. 5).

Table 6. Effect of weather parameter on leaf blight (*Colletotrichum dematium*) of Safed musli

Met. week	Date	Intensity
33	13-19 Aug.	0.0
34	20-26	5.35
35	27-2 Sep.	9.70
36	3-9	12.60
37	10-16	13.12
38	17-23	17.33
39	24-30	18.58
40	1-7 Oct.	24.54
41	8-14	23.94
42	15-21	29.58
43	22-28	32.51
44	29-4 Nov.	35.81
45	5-11	38.66
46	12-18	40.37
47	19-25	40.86

Leaf blight (*Colletotrichum dematium*)

Pathogenicity

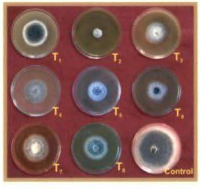


Growth of *Colletrichum dematium* on PDA medium

Acervuli showing setae

Conidia of *C. dematium*

Plate 5(a). Pathogen causing leaf blight in safed musali (*Chlorophytum borivilianum*)



10% concentration

Plate 5(b). Efficacy of different botanicals against *Colletotrichum dematium*

Root rot (*R. bataticola*)

Growth of *R. bataticola* on PDA medium

Sclerotia of *R. bataticola*

Plate 6. *Rhizoctonia bataticola* causing root rot in safed musali (*Chlorophytum borivilianum*)

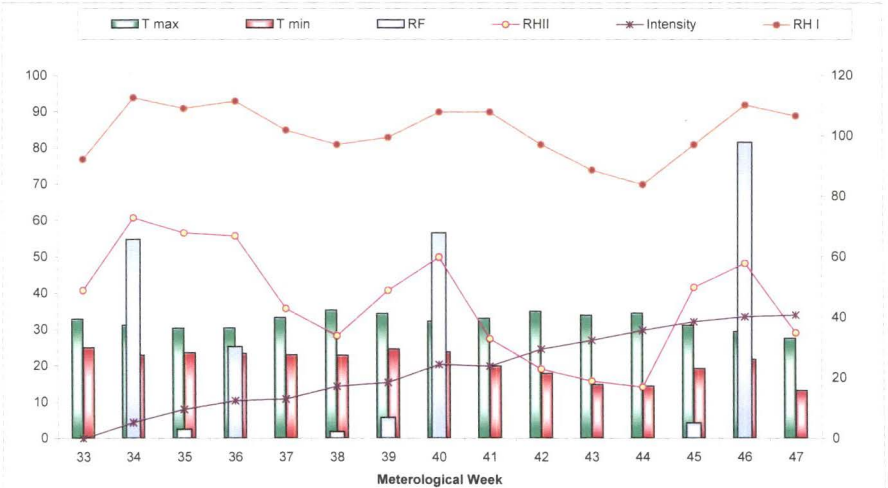


Fig. 5. Effect of weather parameters on leaf blight of Safed musli caused by *Colletotrichum dematium*

Table 6a. Correlation of leaf blight (*Colletotrichum dematium*) of Safed musli with weather parameters

Disease	Per cent	Rainfall (mm)	Temp. (°C) max.	Temp. (°C) min.	RHI Morning (%)	RHII Evening (%)
Leaf blight	Intensity	0.081	-0.181	-0.751**	-0.211	-0.500*

Date of sowing 1st of June

'r' value at 0.01% = 0.645
r' value at 0.05% = 0.456

Correlated data (Table 6a) showed that minimum temperature and relative humidity evening exhibited significant and negative correlation with disease, while positive and non significant correlation was established with rainfall.

Tekade *et al.* (2009) observed contributory and profound effect of all weather parameter to correlate with disease development.

Table 7. Efficacy of different botanicals at 5% and 10% concentration against *Colletotrichum dematium* causing leaf blight in Safed musli

Plants extract	Concentration (5%)		Concentration (10%)	
Treatments	Mean colony diameter (mm)	Per cent Growth Inhibition	Mean colony diameter (mm)	Per cent Growth Inhibition
T_1 *Prosofis juliflora*	56.44	36.89	52.55	41.53
T_2 *Azadirachta indica*	23.22	74.03	17.66	80.35
T_3 *Nerium oleander*	53.21	40.50	47.88	46.72
T_4 *Lantana camera*	55.77	37.64	48.66	45.86
T_5 *Eucalyptus* sp.	46.77	47.70	38.99	56.61
T_6 *Jatropha gossypifolia*	50.55	43.48	42.77	52.41
T_7 *Ipomea carnea*	49.55	44.59	49.55	44.87
T_8 *Pongamia pinnata*	53.10	40.63	48.33	46.22
T_9 Control	89.44		89.88	
F test	Sig.		Sig.	
SE(M)	0.70		0.29	
CD(P= 0.01)	3.21		1.33	

The result presented in the Table 7, revealed that all the treatments were significantly superior over control at both level of concentration. At 5 % concentration the extracts of *Azadirachta indica* produced maximum per cent growth inhibition i.e. 74.03% followed by *Eucalyptus* sp. (47.70%) and *Ipomea carnea* (44.59%).

At 10 % concentration also *Azadirachta indica* produced maximum per cent growth inhibition i.e. 80.35%. Next best treatments were *Eucalyptus* sp. (56.61%), *Jatropha gossypifolia* (52.41) and *Nerium oleander* (46.72).The *Prosofis juliflora* showed the minimum per cent growth inhibition at 5 % as well as 10 % level of concentration.

Sinha *et al.* (2004) also reported that plant extract of *Azadirachta indica* effective in the management of *Colletotrichum capsici.* Plate 5 (b) (Fig. 6)

This observation are in the agreement with the findings of earliar workers (Yadav *et al.* 2009) The most active plant inhibiting mycelial growth of the test fungus more than 60 per cent was *Azadirachta indica* 87 per cent against *Colletotrichum falcatum.*

Shivpuri *et al.* (1997) proved the present studies inhibitory and agreed with the fungitoxic effect of *Azadirachta indica* extract containing high level of antifungal compound (azadirachtin).

4.3.2.2 Root rot (*Rhizoctonia bataticola*)

Safed musli was found to infect with root rot disease. The disease started from the planting time. Initially yellowing of leaves was observed and under serious infection complete rotting of the roots was observed resulting in the death and decay of whole plant. The collar portion of infected plants was occasionally girdled with the fungus.

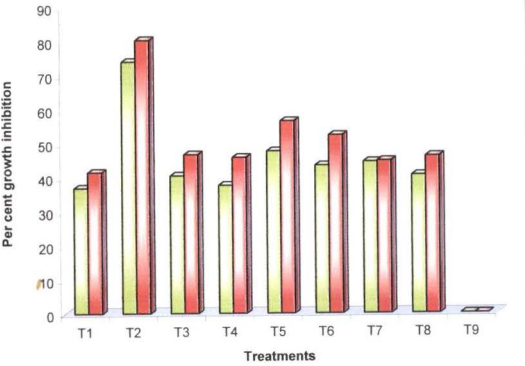


Fig. 6. Efficacy of different botanicals at 5% and 10% concentration against *Colletotrichum dematium* causing leaf blight in Safed musli

T1	-	*Prosofis juliflora*
T2	-	*Azadirachta indica*
T3	-	*Nerium oleander*
T4	-	*Lantana camera*
T5	-	*Eucalyptus* sp.
T6	-	*Jatropha gossypifolia*
T7	-	*Ipomea carnea*
T8	-	*Pongamia pinnata*
T9	-	Control

The fungus associated with root rot was identified as *Rhizoctonia bataticola*. The pathogenic ability was also assessed by inoculating culture. The symptoms were observed that to under natural conditions which confirm the pathogenicity. (Plate 6)

Mandal *et al.* (2004) recorded the foliar symptoms due to *Macrophomina phaseolina* whole under present investigation severe incidence of root rot was noted due to *Rhizoctonia bataticola*. Verma and Sharma (2007) reported that *F. solani* and *R. solani* were causal pathogen for root rot.

4.3.3 Korpad (*Aloe vera)*

During present investigation korpad was found to infected by two diseases i.e. Leaf spot and base rot/ root rot. The infection resulted in a significant reduction in leaf area harvested for the purpose of gel extraction and thus caused a direct economic loss.

4.3.3.1 Leaf spot (*Phoma* sp.)

The symptoms of the disease consist of spots. These spots were oval to spherical in shape, numerous in size, water soaked and superficial in nature. The dark sunken area of the spot penetrates deep into the gel portion and after drying become corcky. The colour of these spots was dark brown to black, some bigger spots may coalesced to form large necrotic areas of the leaf. The spots were mostly found the tip portion of the leaf. Infected specimens were collected and the fungus was isolated and obtained in pure form. The pathogen was identified as *Phoma* sp. on the basis of morphological characters. Plate 7(a)

Table 8. Effect of weather parameter on leaf spot (*Phoma* sp.) of Korpad

Met. week	Date	Per cent Disease Intensity
28	9-15 July	0.0
29	16-22	12.80
30	23-29	14.23
31	30-5 Aug.	15.28
32	6-12	17.86
33	13-19	18.00
34	20-26	21.85
35	27-2 Sep.	24.00
36	3-9	24.44
37	10-16	25.50
38	17-23	26.65
39	24-30	28.49
40	1-7 Oct.	31.48
41	8-14	25.92
42	15-21	32.12
43	22-28	35.00
44	29-4 Nov.	39.62
45	5-11	43.70
46	12-18	51.85
47	19-25	53.33
48	26-2 Dec.	56.67
49	3-9	48.54
50	10-16	45.18
51	17-23	54.44
52	24-31	54.81

Table 8a. Correlation of leaf spot (*Phoma* sp.) of Korpad with weather parameters

Disease	Per cent	Rainfall (mm)	Temp. (°C) max.	Temp. (°C) min.	RHI Morning (%)	RHII Evening (%)
Leaf spot	Intensity	-0.182	-0.365	-0.827**	-0.151	-0.603**

Date of sowing 3rd to 4th July

'r' value at 0.01% = 0.485
r' value at 0.05% = 0.345

Seasonal incidence

A perennial medicinal crop was found to be infected with leaf spot caused by *Phoma* sp. The initiation of disease was noted during 29th met week with an intensity of 12.80%. The intensity was reached to its peak i. e. 56.67% during 48th met week. The environmental feature of proceeding week i. e. rainfall 0.0 mm, 27.5 ^{0}C and 13.1^{0}C maximum and minimum temperature, RH I and RH II 89% and 35% respectively might be responsible for increase in the disease intensity. Later intensity was declined to 45.18 per cent during 50th met week. The correlation of weather parameters showed that minimum temperature and relative humidity evening exhibit negative and significant correlation with disease at both level of significance. Other parameter exhibit negative and non significant correlation. (Table 8, 8a) (Fig. 7)

Sharma and Samota (2007) observed the leaf spot caused by *Phoma exigua*. Roy (1976) also stated that the causal organism of leaf spot of *Aloe vera* was *Phoma sorghina* while Majumdar *et al.* (2007) reported *Ascochyta* sp. as a causal pathogen.

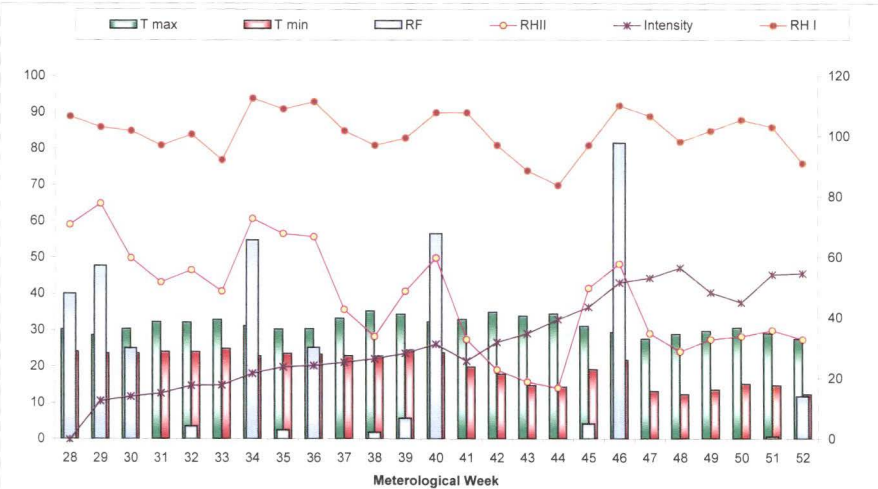


Fig. 7. Effect of weather parameters on leaf spot of Korpad caused by *Phoma* sp.

Table 9. Efficacy of different botanicals at 5% and 10% concentration against *Phoma* sp. causing leaf spot of Korpad

Plants extract	Concentration (5%)		Concentration (10%)	
Treatments	**Mean colony diameter (mm)**	**Per cent Growth Inhibition**	**Mean colony diameter (mm)**	**Per cent Growth Inhibition**
T_1 *Prosofis juliflora*	45.32	49.13	42.77	52.11
T_2 *Azadirachta indica*	45.55	48.87	42.44	52.48
T_3 *Nerium oleander*	61.77	30.67	59.21	33.71
T_4 *Lantana camera*	60.99	31.54	58.66	34.32
T_5 *Eucalyptus* sp.	35.77	59.85	31.33	64.92
T_6 *Jatropha gossypifolia*	34.22	61.59	30.22	66.16
T_7 *Ipomea carnea*	29.00	67.45	24.55	72.51
T_8 *Pongamia pinnata*	61.44	31.04	58.55	34.44
T_9 Control	89.10		89.32	
F test	Sig.		Sig.	
SE(M)	0.53		0.39	
CD(P= 0.01)	2.45		1.79	

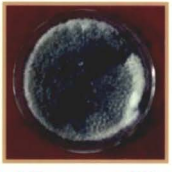
From Table 9, at 5% concentration *Ipomea carnea* (29.00 mm), *Jatropha gossypifolia* (34.22 mm), *Eucalyptus* sp. (35.77 mm), *Prosofis juliflora* (45.32 mm) and *Azadirachta indica* (45.55 mm) were more sensitive and restricted the mycelial growth of *Phoma* sp. The maximum per cent growth inhibition was noticed in *Ipomea carnea* i.e. 67.45%.

At 10% concentration *Ipomea carnea* was the most effective treatment whereas *Nerium oleander* leaves extract was least effective in reducing the mycelial growth of the test fungi in both level of concentration. Plate 7(b) (Fig. 8)

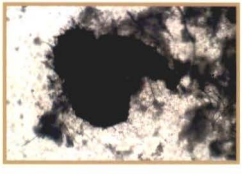
Joseph *et al.* (2008) used different concentration 5, 10, 15 and 20 per cent in the study.

Leaf spot (*Phoma* sp.)

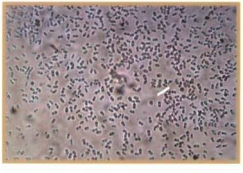
Leaf spot at the tip portion of leaf



Growth of *Phoma* sp. on PDA medium

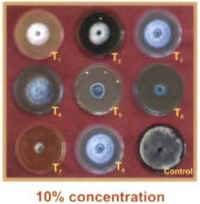


Pycnidium



Pycnidiospores

Plate 7(a). *Phoma* sp. causing leaf spot in Korpad (*Aloe barbendisis*)



10% concentration

Plate 7(b). Efficacy of different botanicals against *Phoma* sp.

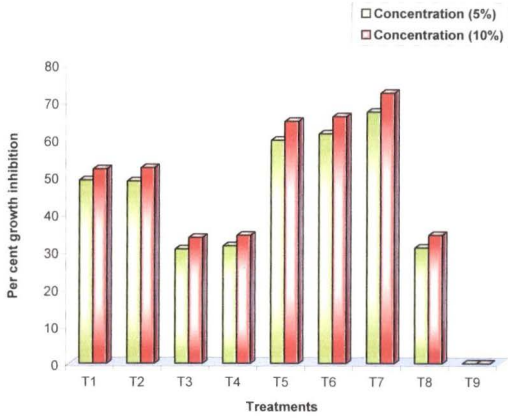


Fig. 8. Efficacy of different botanicals at 5% and 10% concentration against *Phoma* sp. causing leaf spot of Korpad

T1	-	*Prosofis juliflora*
T2	-	*Azadirachta indica*
T3	-	*Nerium oleander*
T4	-	*Lantana camera*
T5	-	*Eucalyptus* sp.
T6	-	*Jatropha gossypifolia*
T7	-	*Ipomea carnea*
T8	-	*Pongamia pinnata*
T9	-	Control

4.3.3.2 Base rot / Root rot (*Fusarium semitectum*)

The infection appears at the base and on leaf surface also of an older or mature leaves which show yellowish, brown to black necrotic rot. Under severe infection, the leaves droop and fall. This may lead to partial or complete defoliation of the plant depending on severity of infection. The causal organism was isolated and identified as *Fusarium semitectum*. (Plate 8a)

Ayodele and Ilondu (2008) also reported the similar type of symptoms caused by *Fusarium oxysporum*. *Fusarium solani* was the causal agent of root rot reported by Majumdar *et al.* (2007). Association of different pathogen might be due to varied type of geographical situation.

Table 10. Efficacy of different botanicals at 5% and 10% concentration against *Fusarium semitectum* causing base rot of Korpad

Plants extract	Concentration (5%)		Concentration (10%)	
Treatments	**Mean colony diameter (mm)**	**Per cent Growth Inhibition**	**Mean colony diameter (mm)**	**Per cent Growth Inhibition**
T_1 *Prosofis juliflora*	37.77	57.92	26.44	70.43
T_2 *Azadirachta indica*	31.77	64.60	29.10	67.46
T_3 *Nerium oleander*	72.44	19.30	62.77	29.81
T_4 *Lantana camera*	72.66	19.05	63.66	28.82
T_5 *Eucalyptus* sp.	54.99	38.74	48.33	45.96
T_6 *Jatropha gossypifolia*	44.77	50.12	42.66	52.30
T_7 *Ipomea carnea*	30.33	66.21	30.22	66.21
T_8 *Pongamia pinnata*	72.66	19.05	63.44	29.06
T_9 Control	89.77		89.44	
F test	Sig.		Sig.	
SE(M)	0.21		0.27	
CD(P= 0.01)	0.96		1.24	

The result in Table 10 indicated that all plant extracts were found singnificantly superior over control except *Nerium oleander, Lantana camera and Pongamia pinnata.* At 5 % concentration maximum per cent growth inhibition was achived due to *Ipomea carnea* leaf extracts (66.21%) followed by *Azadirachta indica* (64.60%), *Prosofis juliflora* (57.92%) and *Jatropha gossypifolia* (50.12%).

At 10 % concentration *Prosofis juliflora* was more effective in controlling the growth of the fungi and the per cent growth inhibition was (70.43%). The above treatment was followed by *Azadirachta indica* 67.46%, *Ipomea carnea* (66.21%), *Jatropha gossypifolia* 52.30%, *Eucalyptus* sp. 45.96%. However, the least reduction in mycelial growth of the test fungus was due to *Lantana camera* (63.66 mm). Plate 8(b) (Fig. 9)

The extract of *Prosofis juliflora* (20 per cent) was promising in inhibiting the growth of the fungus *in vitro*. Kishore and Pande (2005). *Lantana camera* and *Pongamia glabra* have not been found to posses any inhibitory effect against tested fungi. (Bambode and Shukla 1973).

4.3.4 Lendi pimpli (*Piper longum)*

4.3.4.1 Leaf blight (*Colletotrichum gloeosporiodes)*

The disease was observed in the form of small dull pale pinhead spots with yellowish brown, dots at initial stage on leaves. All the aerial parts were observed to be infected. The spots were circular to irregular dark brown in colour, later coalesced to each other and form necrotic areas on leaves and stem. The disease was appeared soon after the rains. Severely infected leaves shed prematurely. The incidence was more on older leaves.

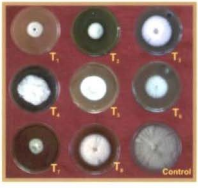
Root rot / Base rot

Pathogen on root portion

Growth of *Fusarium semitectum* on PDA medium

Micro and Macro conidia of *F. semitectum*

Plate 8(a). *Fusarium semitectum* causing root rot in Korpad (*Alove barbadensis*)



10% concentration

Plate 8(b). Efficacy of different botanicals against *F. semitectum*

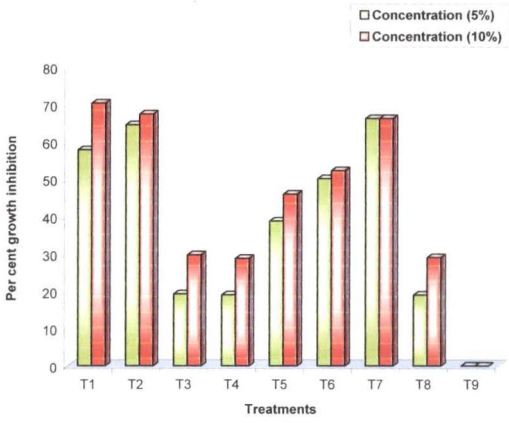


Fig. 9. Efficacy of different botanicals at 5% and 10% concentration against *Fusarium semitectum* causing base rot of Korpad

T1	-	*Prosofis juliflora*
T2	-	*Azadirachta indica*
T3	-	*Nerium oleander*
T4	-	*Lantana camera*
T5	-	*Eucalyptus* sp.
T6	-	*Jatropha gossypifolia*
T7	-	*Ipomea carnea*
T8	-	*Pongamia pinnata*
T9	-	Control

Pathogenicity

The fungus was isolated in pure form and identified as *Colletotrichum gloeosporioides*. The pathogenicity was also proved on excised leaves. The symptoms were observed 5 days after inoculation. Plate 9(a)

Sathyarajan and Naseema (1985), Bhave (2005) recorded *Colletotrichum gloeosporioides* on *Piper longum* by proving pathogenicity by spraying spore suspension. Kuch (1990) reported that *Colletotrichum capsici* and *C. gloeosporioides* are harmful pathogens resulting in blackning of berry. Thus, the pathogen so obtained confirms the previous findings.

4.3.4.2 Leaf spot (*Chaetomium globosum*)

Initiation of symptoms were observed during last week of July. Symptoms consist of water soaked leaf spots, increased rapidly in size and become light and turned to dark brown and black in colour. The spots coalesced resulting in blight symptoms. The blightning generally observed at the tip portion of leaf. Severe infection resulted in defoliation.The pathogen from infected portion was isolated and identified as *Chaetomium globosum*. Pathogenicity was also proved by excised leaf technique. Plate 9(b)

Roy (1976) recorded several fungi with *Chaetomium globosum* causing leaf spot of *Datura metel*.

4.3.5 Coleus (*Coleus forskolii*)

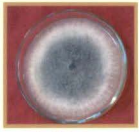
4.3.5.1 Leaf blight

Initially water soaked leaf spots were observed, later increase rapidly in size and become light and then turned to brown in colour. The spots coalesced resulting in blight symptoms. The causal fungus isolated in pure form was *Curvularia lunata*. The identity was confirmed on the basis of published literature.

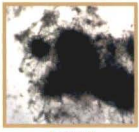
Healthy

Infected

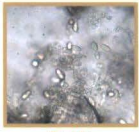
Pathogenicity



Pure growth of *C. gloeosporioides*



Acervuli



Conidia

Plate 9(a). *C. gloeosporioides* causing leaf blight of Lendipimpli (*Piper longum*)

Leaf blight (*Chaetomium globosum*)

Pathogenicity

Growth of *C. globosum*

Spores

Plate 9(b). *Chaetomium globosum* causing leaf blight of Lendipimpli (*Piper longum*)

Healthy

Infected

Pathogenicity

Growth of *C. lunata*

Conidia

Plate 10. *Curvularia lunata* causing leaf blight of Coleus (*Coleus forskolii*)

The pathogenicity was proved by inoculating the culture under excised leaf technique. The symptoms were developed within 4 to 5 days of inoculation. Similar symptoms was observed under natural condition. On reisolation the same pathogen was observed which leads to confirm the pathogenicity. (Plate 10)

Naseema and Wilson (1991) observed that the leaf blight of coleus due to number of pathogens including *Curvularia sp.* while Shukla *et al.* (1993) reported the leaf blight of coleus forskolii caused by *Rhizoctonia solani.*

4.3.6 Sarpgandha (*Rauvolfia serpentina*)

4.3.6.1 Leaf blight (*Alternaria alternata*)

Rauvolfia serpentina was found to be affected by leaf blight and the causal organism was *Alternaria alternata.* The initial symptoms were in the form of small brownish circular spots with yellowish margin on the ventral surface of tender leaves. Spots at advanced stage formed large dark brownish circular concentric lesions. The entire leaves were infected resulting in blight symptoms. Under severe conditions leaves shade pre maturely. (Plate 11)

Ganguly and Pandotra (1962[b]) also reported the similar type of symptoms caused by *Alternaria* sp.

4.3.6.2 Die back (*Colletotrichum dematium*)

The twigs were infected first and numerous tiny spots were observed on leaves and stem. Acervuli were scattered all over the dried twigs. Severe infection resulted in defoliation, drying and death of tender branches. The causal organism was isolated and identified as *Colletotrichum dematium.* Lele and Ashram (1968), Janardhan *et al.* (1972) observed the *Colletotrichum dematium* a causal pathogen for dieback.

4.3.7 Datura (*Datura innoxia*)

4.3.7.1 Leaf spot (*Alternaria alternata*)

Datura was found to infect by leaf spot disease. The diseased spots were water soaked minute, initially on leaves and at advance stages spot become larger in size and coalesced together. The spot were dark brown round to oval or slightly irregular with necrotic areas resulted in defoliation. The fungal pathogen was isolated in pure form and identified as *Alternaria alternata*.

The pathogenicity was proved by excised leaf technique. The fungus was proved to be pathogenic and developed the symptoms within 3 days of inoculation. (Plate 12)

Ganguly and Pandatra (1962[a]) stated that *Alternaria tenuissima* infects the crop and causes severe defoliation. Early infection due to *Alternaria alternata* in the form of circular spots on leaves finally death of the tissues with concentric rings were reported by Janardhan and Husain (1972). Roy (1976) also reported *Alternaria alternata* cause leaf spot disease of Datura metel.

Aromatic plants

Aromatic plants are the major source of essential oil. Oil are obtained from the leaves is used by the perfumery, cosmetics and pharmaceutical industries for various purposes. Most of the disease like leaf blight, leaf spot attack the foliage part of the plant like leaves, stem etc. Generally oil and essential secondary metabolite are extracted from the foliar parts. Hence due to severity of the various disease great losses are reported.

The reported diseases and there symptoms are discussed below.

Healthy

Infected (*Alternaria alternata*)

Spores with mycelium

Plate 11. ***Alternaria alternata*** **causing leaf blight in Sarpagandha (*Rauvolfia serpentina*)**

Leaf spot

Pathogenicity

Plate 12. ***Alternaria alternata*** **causing leaf spot of Dathura (*Dathura innoxia*)**

4.3.8 Tikhadi (*Cymbopogan martinii*)

4.3.8.1 Leaf blight (*Curvularia lunata*)

The initial symptoms of the disease appear as small, circular to ovoid, light brown spots on the leaf blades. The spot enlarges in later stage. In advanced stage of infection, the spots coalesced together and cause premature death and drying of the leaves. The isolation yielded a species of *Curvularia*. And the pathogen was identified as *Curvularia lunata*. Plate 13(a)

The pathogenicity was proved by adopting excised leaf technique under laboratory conditions. The symptoms were developed within 5 days after inoculation.

Table 11. Effect of weather parameter on leaf blight (*Curvularia lunata*) of Tikhadi

Met. week	Date	Per cent Disease Intensity
33	13-19 Aug.	0.0
34	20-26	2.56
35	27-2 Sep.	10.45
36	3-9	12.05
37	10-16	15.32
38	17-23	16.36
39	24-30	17.96
40	1-7 Oct.	22.83
41	8-14	25.55
42	15-21	31.58
43	22-28	33.16
44	29-4 Nov.	35.42
45	5-11	44.00
46	12-18	44.55
47	19-25	40.00

Seasonal incidence

A seasonal aromatic crop was found to be infected with leaf blight caused by *Curvularia lunata*. The initiation of disease was noted during 34th met week with intensity 2.56%. Later disease was gradually increased and was reached to its peak i.e. 44.55% during 3rd week of November (46th met. week). Weather features of proceeding week i.e. Maximum and minimum temperature was 31.0 and 19.1^{0}C with relative humidity of morning and evening 81 and 50% might be responsible to develop the disease. The intensity was declined to the extent of 40.00% during 47th met week. (Table 11) (Fig. 10)

Table 11a. Correlation of leaf blight (*Curvularia lunata*) of Tikhadi with weather parameters

Disease	Per cent	Rainfall (mm)	Temp. (°C) max.	Temp. (°C) min.	RHI Morning (%)	RHII Evening (%)
Leaf blight	Intensity	0.049	-0.183	-0.710**	-0.209	-0.481*

Date of sowing 22nd to 25th May

'r' value at 0.01% = 0.645
r' value at 0.05% = 0.456

Relative humidity evening and minimum temperature exhibited significant and negative correlation with disease while rainfall was positive and non significant. Increase in the disease intensity might be due to contributory effect of weather parameter. (Table 11a)

Alam *et al.* (1979) observed the similar type of symptom on *Cymbopogan pendulus* caused by *Curvularia trifolii*. The pathogenicity was also proved. Barua and Bordoloi (1983) stated the leaf spot on lemongrass caused due to *Curvularia verruciformis* while the causal agent of leaf blight or foliage blight was *curvularia andropogonis* reported by Monteiro and

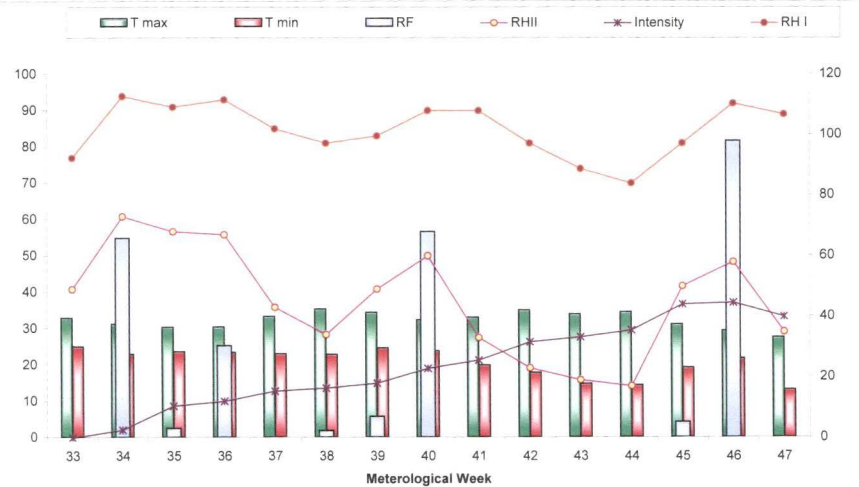


Fig. 10. Effect of weather parameters on leaf blight of Tikhadi caused by *Curvularia lunata*

Barreto (2002), Lakpale *et al.* (2005) thus, the findings of present studies are on the line of published results.

Table 12. Efficacy of different botanicals at 5% and 10% concentration against *Curvularia lunata* causing leaf blight of Tikhadi

Plants extract	Concentration (5%)		Concentration (10%)	
Treatments	**Mean colony diameter (mm)**	**Per cent Growth Inhibition**	**Mean colony diameter (mm)**	**Per cent Growth Inhibition**
T_1 *Prosofis juliflora*	49.33	45.11	40.55	54.88
T_2 *Azadirachta indica*	38.55	57.10	35.55	60.44
T_3 *Nerium oleander*	84.77	05.68	73.77	17.92
T_4 *Lantana camera*	44.66	50.31	39.88	55.62
T_5 *Eucalyptus* sp.	24.44	72.80	24.22	73.05
T_6 *Jatropha gossypifolia*	54.99	38.81	49.33	45.11
T_7 *Ipomea carnea*	51.77	42.40	50.33	44.00
T_8 *Pongamia pinnata*	84.77	05.68	73.55	18.16
T_9 Control	89.88		89.88	
F test	Sig.		Sig.	
SE(M)	0.35		0.25	
CD(P= 0.01)	1.60		1.14	

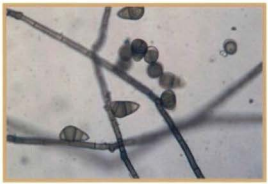
Among the plant extracts tested against *Curvularia lunata* at 5% concentration *Eucalyptus* sp. was found most effective with maximum per cent growth inhibition was 72.80%. The next best treatments were *Azadirachta indica* (38.55 mm) and *Prosofis juliflora* (49.33 mm).

At 10 % concentration also *Eucalyptus* sp. was found to be more effective against *Curvularia lunata* followed by *Azadirachta indica* (35.55 mm), *Lantana camera* (39.88 mm) and *Nerium oleander* was showed minimum per cent growth inhibition i.e. 17.92%. Plate 13(b) (Table 12) (Fig. 11)

Healthy

Infected

Growth of *Curvularia lunata* on PDA medium



Conidia

Plate 13(a). *Curvularia lunata* causing leaf blight in Thikhadi (*Cymbopogan martinii*)

10% concentration

Plate 13(b). Efficacy of different botanicals against *C. lunata*

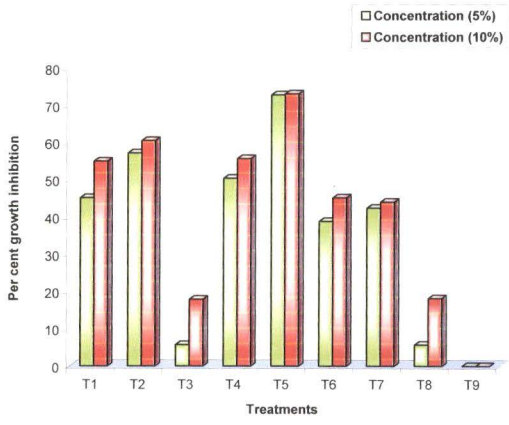


Fig. 11. Efficacy of different botanicals at 5% and 10% concentration against *Curvularia lunata* causing leaf blight of Tikhadi

T1	-	*Prosofis juliflora*
T2	-	*Azadirachta indica*
T3	-	*Nerium oleander*
T4	-	*Lantana camera*
T5	-	*Eucalyptus* sp.
T6	-	*Jatropha gossypifolia*
T7	-	*Ipomea carnea*
T8	-	*Pongamia pinnata*
T9	-	Control

Bharad and Khune (1988) reported that leaf extract of *Azadirachta indica* and *Eucalyptus globules* had a antifungal properties at 5 per cent concentration against *Curvularia lunata*. These result confirm the present finding in regarded to efficacy of botanicals.

4.3.9 Pudina (*Mentha arvensis*)

4.3.9.1 Die back

During regular survey mint was observed to be infected with the foliar disease. The first symptoms were noted on foliage in the form of water soaked lesions. The blackning of stem, branches and leaves midrib along with the veins was observed. The symptoms developed in the form of blackish irregular or circular spot with concentric rings having dot like acervuli structure. The older leaves shaded prematuarly. Under sever condition defoliation was recorded.

The fungus was isolated from the infected lesions on PDA and identified as *Colletotrichum lini*. The pathogenicity was also proved on excised leaves. The symptoms were observed after 5 days of inoculation. The pathogen was reisolated from inoculated tissue. Plate 14 (a)

Colletotrichum dematium was the causal agent of die back reported by Lele and Ashram (1968), Janardhanan *et al.* (1972) on different medicinal plant. However under Akola climate die-back was caused due to *Colletotrichum lini* with maximum intensity 48.90% during last week of December.

Seasonal incidence

The initiation of die back was observed during first week of August 2009 i.e. 31st met week with an intensity of 2.00 % when the maximum and minimum temperature was 32.2 and 24^{0}C along with relative humidity ranged between 81 to 52 percent with rainfall 0.0 mm. Later disease intensity gradually increased and maximum percent disease intensity i.e. 48.90 was observed during 52nd met week. When weather

factors prevailed during 51st met week i.e. rainfall 0.7 mm, maximum temperature 29.0°C and minimum 14.7°C, relative humidity morning and evening (86% and 36%) were responsible for increase in the disease intensity.(Table 13) (Fig. 12)

Table 13. Effect of weather parameter on leaf blight (*Colletotricum lini*) of Pudina

Met. week	Date	Per cent Disease Intensity
28	9-15 July	0.0
29	16-22	0.0
30	23-29	0.0
31	30-5 Aug.	2.00
32	6-12	3.00
33	13-19	8.69
34	20-26	10.26
35	27-2 Sep.	12.22
36	3-9	13.34
37	10-16	13.85
38	17-23	15.33
39	24-30	18.69
40	1-7 Oct.	24.34
41	8-14	27.14
42	15-21	28.39
43	22-28	34.81
44	29-4 Nov.	35.00
45	5-11	36.12
46	12-18	38.00
47	19-25	39.65
48	26-2 Dec.	42.50
49	3-9	45.60
50	10-16	47.83
51	17-23	48.00
52	24-31	48.90

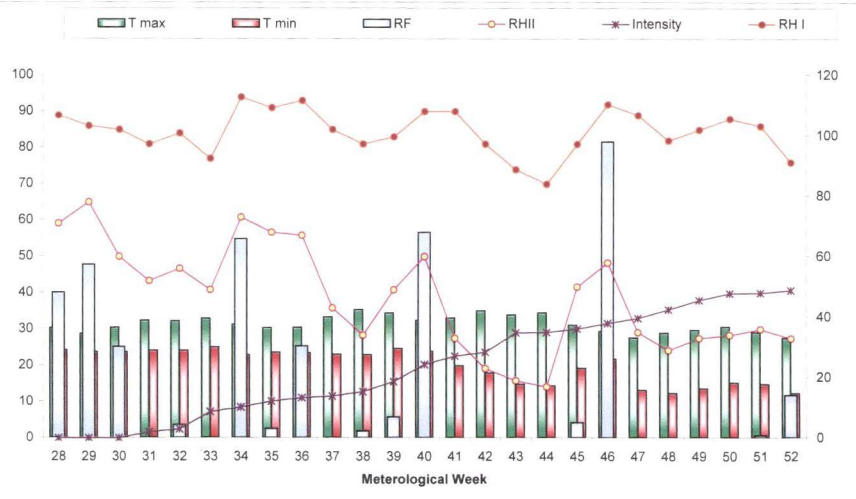


Fig. 12. Effect of weather parameters on leaf blight of Pudina caused by *Colletotrichum lini*

Table 13a. Correlation of leaf blight (*Colletotrichum lini*) of Pudina with weather parameter

Disease	Per cent	Rainfall (mm)	Temp. (°C) max.	Temp. (°C) min.	RHI Morning (%)	RHII Evening (%)
Leaf blight	Intensity	-0.238	-0.269	-0.878**	-0.194	-0.692**

Date of sowing 20th to 27th Jan.

'r' value at 0.01% = 0.645
r' value at 0.05% = 0.456

All the weather parameters correlated with disease were found to be negative only temperature minimum and relative humidity evening were significant with die-back caused by *Colletotrichum lini.* (Table 13a)

Table 14. Efficacy of different botanicals at 5% and 10% concentration against *Colletotrichum lini* causing leaf blight of Pudina

Plants extract	Concentration (5%)		Concentration (10%)	
Treatments	Mean colony diameter (mm)	Per cent Growth Inhibition	Mean colony diameter (mm)	Per cent Growth Inhibition
T_1 *Prosofis juliflora*	63.66	28.99	53.33	40.51
T_2 *Azadirachta indica*	32.22	64.06	25.11	71.99
T_3 *Nerium oleander*	52.77	41.14	46.11	48.57
T_4 *Lantana camera*	53.22	40.64	45.77	48.95
T_5 *Eucalyptus* sp.	45.44	49.64	39.77	55.64
T_6 *Jatropha gossypifolia*	49.77	44.49	44.88	49.94
T_7 *Ipomea carnea*	50.44	43.47	45.22	49.56
T_8 *Pongamia pinnata*	52.88	41.02	45.77	48.95
T_9 Control	89.66		89.66	
F test	Sig.		Sig.	
SE(M)	0.40		0.36	
CD(P= 0.01)	1.83		1.65	

The above botanicals were tested against *Colletotrichum lini* causing leaf blight of Pudina (*Mentha arvensis).* At 5 % concentration all the treatments were significantly superior over control except *Prosofis juliflora* from Table 14, *Azadirachta indica* was the efficient treatment which produced only 32.22 mm growth against 89.66 mm in control. The above treatment was followed by *Eucalyptus* sp. (45.44 mm) and *Jatropha gossypifolia* (49.77 mm) with the maximum per cent growth inhibition was 49.64%, 44.49% respectively.

At 10 % concentration also *Azadirachta indica* showed maximum (71.99 %.) inhibition of mycelial growth which was significantly superior over all other plants extract. The minimum per cent growth inhibition was of *Prosofis juliflora* (40.51%) at 10% and (28.99%) at 5%. Plate 14 (b) (Fig. 13)

Watve *et al.* (2009) studied relative effectiveness of leaf extract of some plant against *Colletotrichum gloesporiodes,* among the plant extract maximum inhibition was achieved due to neem leaf extract (78.15%) and was significantly superior over all other plant extracts. Yadav (1986) stated that neem leaf extract (2%) reported more than 60 per cent fungal inhibition by poison food technique. The findings of present studies are on the line of published results.

4.3.10 Khus (*Vetiveria zizanioides*)

4.3.10.1 Foot rot/ Root rot (*Sclerotium rolfsii*)

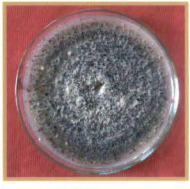
Vetiver grass is an important essential oil yielding plant and assumed importance in waterland management programme. Roots of vetiver are used for variety of purpose but due to attack of fungal pathogen it loss there economic value.

The vetiver grass was affected by root rot. The infected plants showed yellowing of leaves followed by drooping, blackning of collar region

Healthy

Infected

Pathogenicity



Growth of *Colletotrichum lini* on PDA medium

Conidia

Plate 14(a). *Colletotrichum lini* causing leaf blight in Pudina (*Mentha arvensis*)

10% concentration

Plate 14(b). Efficacy of different botanicals against *Colletotrichum lini*

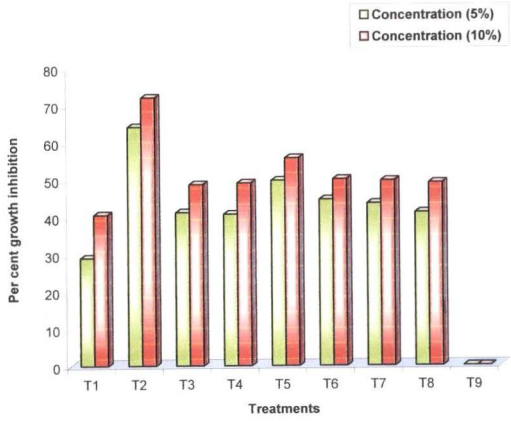


Fig. 13. Efficacy of different botanicals at 5% and 10% concentration against *Colletotrichum lini* causing leaf blight of Pudina

T1	-	*Prosofis juliflora*
T2	-	*Azadirachta indica*
T3	-	*Nerium oleander*
T4	-	*Lantana camera*
T5	-	*Eucalyptus* sp.
T6	-	*Jatropha gossypifolia*
T7	-	*Ipomea carnea*
T8	-	*Pongamia pinnata*
T9	-	Control

and rotting of and roots. The pathogen produced milky or cottony growth on infected portion. The *sclerotia* were whitish when young becoming brown on aeging and spherical in shape. The discoloured collar portion showed shredding. Complete drying of plant observed under severe condition and plants were easily pulled out. After drying of plants abundant matured *sclerotia* fall of and mixed in the soil. On artificial inoculation the plants developed symptoms similar to observed under field conditions.

The pathogen was isolated from infected part and confirmed as *Sclerotium rolfsii* on the basis of morphology. (Plate 15). The present result confirmed by the finding of earliar worker Patil (1995) studied in detail about the *Sclerotium rolfsii* causing foot rot of vetiver.

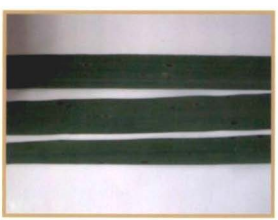
4.3.11 Jawa citronella (*Cymbopogan nardus*)

Citronella grass also observed to be infected with leaf blight disease. The disease was recognised initially as small pink coloured circular spot on the leaf surface and as the disease advances the pink coloured spot turned brown enlarged and spread to form brown patches. The fungi was isolated from infected lesions and identified as *Curvularia lunata*. Satu and Ohkubo (1990) also reported the leaf blight of citronella grass caused by *Curvularia andropogonis*. Thus, these findings confirm the present result. (Plate 16)

Infected

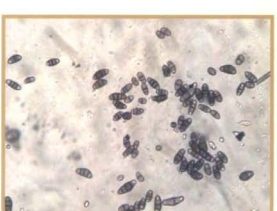
Growth of *Sclerotium rolfsii* on PDA medium

Plate 15. ***Sclerotium rolfsii*** **causing root rot in Khus (*Vetiveria zizanioides*)**



Leaf spot (*Curvularia lunata*) of Jawa citronella

Growth of *C. lunata*



Conidia

Plate 16. ***Curvularia lunata*** **causing leaf blight of Jawa citronella (*Cymbopogon nardus*)**

CHAPTER V

SUMMARY AND CONCLUSION

Medicinal and aromatic crops are firmly emerging on the scene in Indian agriculture. They are useful for various purpose hence the demand increasing day by day and thus commercial cultivation increases. But now a days the diseases have been noticed to tremendously reduce the yield of medicinal and aromatic plants. Hence the present study was carried out under the title "Cause and management of fungal diseases of some medicinal and aromatic plants" in Department of Plant pathology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Studies were conducted to know the occurance, intensity of major fungal diseases of medicinal and aromatic plants. Correlations with weather parameter, proving pathogenicity and *in vitro* management of major diseases causing pathogens by using different botanicals.

Total eighteen medicinal and aromatic plants were constantly observed for occurance of disease and showing the disease symptoms were collected from Nagarjun Research Unit, Akola and Betelvine Research Station, Diwthana. Disease causing pathogens were isolated and identified on the basis of morphology. Pathogenicity of isolated pathogens were also proved.

Ashwagandha crop was found to infected with two diseases i.e. leaf blight (*Alternaria* sp.) and the maximum intensity of leaf blight was 42.63% and a root rot caused by *Fusarium solani* with an incidence 81% was recorded during December. Negative and significant correlation was obtained with minimum temperature and relative humidity evening with leaf

blight while positive and significant correlation was recorded with maximum and minimum temperature with root rot of Ashwagandha.

Colletotrichum dematium caused leaf blight of Safed musli with intensity of 40.86% during 2nd fortnight of December. Negative and significant correlation was obtained with minimum temperature at both level of significance while with the relative humidity evening showed significant correlation at 0.05% level of significance.

Korpad was found to infected with leaf spot (56.67%) caused by *Phoma* sp. and another type of disease was root rot/ base rot caused by *Fusarium semitectum*.

Piper longum was susceptible to *Colletotrichum gloeosporioides* and *Chetomium globosum* caused leaf blight isolated from different location. *Alternaria alternata* caused leaf blight in Sarpagandha and leaf spot in Datura. Coleus was found to be infected with *Curvularia lunata* causing leaf blight.

Among aromatic plants Pudina was found infected with leaf blight (48.90%) caused by *Colletotrichum lini, Curvularia lunata* caused leaf blight (44.55%) of Tikhadi and Jawa citronella. *Sclerotium rolfsii* cause root rot in khus.

The botanicals were tested against all the test pathogens by poisoned food technique to study their efficacy. Among the different botanicals tested *Azadirachta indica* at 5 per cent and 10 per cent concentration was found to be effective against *Colletotrichum dematium* and *Colletotrichum lini. Ipomea carnea* was found effective against *Fusarium solani*, *Phoma* sp., *Fusarium semitectum* (Korpad) while *Eucalyptus* sp. against *Alternara* sp. and *Curvularia lunata*.

The least efficient botanicals were *Nerium oleander, Lantana camera, Pongamia pinnata* etc.

Conclusion

It is concluded from the finding of the present studies that *Colletotrichum, Alternaria* and *Curvularia* were predominant fungal pathogens causing diseases in medicinal and aromatic plants.

Initiation of almost all the diseases of medicinal and aromatic plant was observed during the period of July- August.

Ashwagandha was infected severly due to leaf blight (*Alternaria* sp.) with an intensity of 42.63% and root rot (*Fusarium solani*) with incidence 81% at the time of harvesting i.e. during last fortnight of December.

The higher intensity of *Colletotrichum* blight of Safed musli was observed during 2nd fortnight of November i.e. 40.86%. *Phoma* sp. caused leaf spot on *Aloe vera* with intensity of 54.81%.

Among the aromatic plants Pudina was found to be infected with *Colletotrichum lini* causing leaf blight to the extent of 48.90%. Tikhadi was also found to be infected with leaf blight caused by *Curvularia lunata* with an intensity of 44.55% during 2nd fortnight of November.

Among all the botanicals tested *Eucalyptus* sp, *Azadirachta indica, Ipomea carnea* provided high inhibitory effect against tested pathogen.

CHAPTER VI

LITERATURE CITED

Ahir, R. R., S. K. Tak, N. Singh and O. P. Verma. 2006. Two new diseases of medicinal plant caused by *Fusarium solani*. J Mycol Pl. Pathol. 36(1):18.

Alam, M., K. P. Singh and A. Husain. 1979 A new leaf spot disease of *Cymbopogan pendulus*. Indian J. Mycol. Pl. Pathol. 9 (1):272-273.

Alam, S. 2004. Post infectional biochemical changes due to *Colletotrichum gloeosporioides* in *Piper longum* Linn. M.Sc. (Agri.) Thesis (Unpub.), Dr. PDKV, Akola.

Ayodele, S. M. and E. M. Ilondu. 2008. Fungi associated with base rot of *Aloe vera* (*Aloe barbadensis*) African J. Biotechnology 7(24): 4471-4474.

Bambode, R. S. and V. N. Shukla. 1973. Antifungal properties of certain plant extracts against some fungi. PKV Res. J. 2 (1): 1-8.

Barua, A. and D. N. Bordoloi. 1983. Record of new disease of lemon grass (*Cymbopogan fleuosus* Stapt.) caused by *Curvularia verruciformis*. Current Sci. 52(3):641.

Bharad, D. N. and M. N. Khune. 1988. Studies on antifungal properties of plant extract. M.Sc. (Agri.) Thesis (unpub.), Dr. PDKV, Akola.

Bhave, P. C. 2005. Studies on leaf spot and blight of black pepper and their management. M. Sc. (Agri.) Thesis (Unpub.) Dr. PDKV, Akola.

Bhowmik, B. N. and V. Vardhan. 1981. Antifungal properties of some leaf extracts of medicinal plants on *Curvularia lunata*. Indian Phytopath. 34:385-386.

Chastager, G. A., J. M. Ogawa and K. P. V. Sammeta. 1979. Cause and control of damping off in *Plantago ovata*. Pl. Dis. Reptr. 62:929-932.

Chauhan, L. S. and Jyoti Singh. 1977. *Rhizoctonia* leaf blight of lemon grass (*Cymbopogan Flexuosus*). Phytopathol. 11(2):245.

Damicone, J. P. And W. J. Manning. 1987. Influence of management practices on severity of stem and crown rot, incidence of Asparagus minor and yield of crown from transplants. Pl. Dis. 71: 81-84.

Desai, M. V. and P. S. Desai. 1969. Control of downey mildew of isabgol by aurofungin. Hindustan Antibiotic Bull. 1:245-257.

Deshamukh, G. P. and B. P. Kurudkar. 2002. Correlation and regression studies of chilli anthracnose. Progressive Hort. 34(1): 126-127.

Devi, R. K. T. and N. I. Singh. 1999. Occurance of anthracnose (*Colletotrichum gloeosporioides)* on chilli seedlings- a new report. Pl. Dis. Res. 14(1): 78.

Dubey, R. and A. K. Pandey. 2009. A new report on Collar and Root rot Disease of *Aloe vera* caused by *Sclerotium rolfsii*. J. Mycol.Pl. Pathol. 39(2): 300-301.

Ganguly, D. and V. R. Pandotra. 1962[a]. Some commonly occurring diseases of important medicinal and aromatic plants in Jammu and Kashmir. Indian Phytopath. 15: 50-54.

Ganguly, D. and V. R. Pandotra. 1962[b]. Regional Research Laboratory, Jamm. Bull. 1: 42-46.

Gomathi, and B. Kannabiran. 2000. Inhibitory effects of leaf extracts of some plants on the anthracnose of fungi infecting *Capsicum annum*. Indian Phytopath. 53(3): 305-308.

Goswami, B. K., K. A. Kedar, M. L. Rahman, M. R. Islam and P. K. Malaker. 2002. Development of leaf spot of betel vine caused by *Colletotrichum capsici*. Bangladesh J. Pl. Pathol. 18 (1/2): 39-42.

Goyal, R. and N. C. Pathak. 1982. A new leaf spot disease of *Catharanthus roseus* from India. New Botanist. 9: 31-32.

Gupta, B. D. and S. Sen. 1986. Chemical control of leaf spot betelvine caused by *Colletotrichum capsici*. Pesticide, 20 (9): 180-182.

Gupta, M. L., H. B. Singh, A. Kalra, R. Pandey and S. P. Singh 1997. A new leaf spot disease of senna caused by *Colletotrichum gloeosporioides*. Indian J. Pl. Path.15: 95-96.

Gupta, M. L., H. O. Misra, A. Kalra, S. P. S. Khanuja. 2006. Root-rot and wilt: a new disease of ashwagandha (*Withania somnifera*) caused by *Fusarium solani*. J. Medicinal and Aromatic Plant Sciences. 57 (3): 512-513.

Gupta, P. K., N. D. Sharma, S. R. Singh and O. P. Singh. 2007. Fungi associated with medicinal plants of Madhya Pradesh. Annuals Pl. Protection Sci. 15(2): 508-509.

Holcomb, G. F. and M. J. Reed. 1994. First report of *Sclerotinia sclerotiorum* on basil Canada. Pl. Dis. 78: 924.

Jadhav, S. K., M. P. Diwakar, U. K. Sawant, and J. J. Kadam. 2008. Management of leaf spot disease of Kokum *(Garcinia indica)* J. Pl. Dis. Sci. 3(2): 193 - 196.

Jamaluddin, 2005. Problems of Diseases in multipurpose, tree species and medicinal plant in Central India. J. Mycol. Pl. Path. 35(3): 2005.

Janardhanan. K. K., D. Ganguly and A. Husain. 1964. *Fusarium* wilt of *Rauvolfia serpentina*. Curr.Sci. 33: 313.

Janardhanan, K. K. and A. Husain. 1972. A new *Alternaria* blight of *Datura innoxia*. Indian Phytopath. 25 : 461.

Janardhanan, K. K., M. L. Gupta and A. Husain. 1972. Pythium dieback a new disease of *Catharanthus roseus*. Indian Phytopath. 30: 427-428.

Jat, B. L., H. N. Gour and P. Sharma. 2008. Efficacy of phytoextracts and bioagents against *Colletotrichum gloeosporioides* causing banana fruit rot. J. Mycol. Pl. Pathol. 38 (3): 635-638.

Jayasekhar, M. and M. Muthusamy 2000. Influence of weather parameters on the incidence of foot rot of black pepper. Madras Agril. J. 86(4/6): 344-346.

Joseph Babu, M. A. Dar, and V. Kumar 2008. Bioefficacy of plant extracts to control *Fusarium solani* f.sp. Melongenae Incitant of Brinjal wilt. Global J. Biotechnology and Biochemistry 3(2): 56-59.

Kalra, A., T. N. Parameswaran and N. S. Ravindra. 2007. *Rhizoctonia* foliar blight of *Rosmarinus officinalis*. Plant Pathology 42(5): 827-828.

Karade, V. M. and D. M. Sawant. 1999. Screening of various plant extract against *Alternaria alternata*. Medicinal Plants. Indian J. Mycol. Pl. Pathol. 2 : 85-86

Karande M.G., S.P. Raut and A.D. Gawande. 2007. Efficacy of fungicides, bio-organics and plant extracts against *Colletotrichum gloeosporioideSs* and *Fusarium oxysporum*. Annals of Plant Protection Sciences 15(1) : 454-456.

Khan, A. A., Shabina Khan and Maigendra Pratap Singh. 2002 Role of plants in upfilftment of economic potentials of tribals of the dist. Shahdal (M.P.) India. Ad.Plant Sci. 15: 397-400.

Khan, A. S. and N. E. Abdel Karer. 1974. *Alternaria* leaf spot of basil and liquorice the first report. Agric Res. Rev. (Cairo.). 52: 85-88.

Khanzada Shahid Ahmed, Sheikh Muhammad Iqbal and Abida Akram. 2006. In vitro efficacy of plant leaf extracts against *Sclerotium rlfsii* Sacc. Mycopath 4(1): 51-53.

Kishore, K. and Suresh Pandey. 2005. Integrated management of late leaf spot and rust diseases of groundnut (*Arachis hypogaea* L.) with *Prosopis juliflora* leaf extract and chlorothalonil. International J. Pest Management. 51(4): 325-332.

Kodmelwar, R. V. and V. N. Shukla. 1986. Report of leaf blotch disease of turmeric in Vidarbha. Pl. Pathol. 10(1) : 80-81.

Koike, S. T. and R. H. Molinar. 1999. Rust disease on lemon grass in California. Plant Disease, 83(3): 304.

Kuch, T. K. 1990. Diseases of black paper and their management. Malayasian Plant Protection Society. Proc. 3rd International Conference on Plant Protection in the Tropics. 4: 114.

Kumar, M.; S.Kaur and P. Gehlot, 2005. Population dynamics of Mycoflora in Rhizosphere of medicinal plant of Western Rajasthan. J. Mycol. Pl. Pathol. 35(3):550.

Kumar, N. 1997. Introduction to Spices, Plantation crops, Medicinal and Aromatic plants. New Delhi, Oxford and IBH Publishing CO. PVT. LTD.

Kumaran, R. S., V. Gomathi and B. Kannabiran, 2003. Fungitoxic effects of root extracts of certain plants species on *Colletotrichum capsici* causing anthracnose in *Capsicum annum*. Indian Phytopath. 56(1): 114-116.

Lakpale, N., C. S. Shukla and V. S. Thrimurty. 2005. Occurrence of diseases in medicinal plants of Chhatisgarh. J. Mycol. Pl. Pathol. 35(3): 589.

Lakpale, N., N. Khare and V. S. Thrimurty. 2008. Evaluation of Botanicals for Antimicrobial Properties. J. Mycol. Pl. Pathol. 38(3): 614-617.

Lele, V. C. and Ashram. 1968. Dieback disease of *Rauvolfia serpentina* caused by *Colletotrichum dematium*. Indian Phytopath. 53: 95-98.

Maharshi, R. P. 2006. *Fusarium solani* and *Rhizoctonia bataticola*- cause of seedling mortality of ashwagandha (*Withania somnifera*) and their management. J. Medicinal and Aromatic Plant Sci. 28 (4): 585-588.

Mahmoud Yehia A. G., Mohsen K. H. Ebrahim and Magda M. ALY.2004. Influence of Some Plant Extracts and Microbioagents on Some Physiological Traits of Faba Bean Infected with Botrytis fabae. 28: 519-528.

Maiti, C.K., S. Sen, A.K. Paul, K. Acharya, 2007. *Alternaria alternata* causing leaf blight diseases of some cultivated medicinal plants of lower Gangetic plains of West Bengal. J. Mycolopathol. Res. 45(1): 132-136.

Maiti, C.K., S. Sen, A.K. Paul, K. Acharya. 2007. First report of *Alternaria dianthicola* causing leaf blight on *Withania somnifera* from India. American Phytopathological Society Plant Disease 91(4): 467.

Maiti, S. and C. Sen, 1985. Incidence of two major diseases of betelvine in relation to weather. Indian Phytopath. 35(1): 14-17.

Majumdar, V. L., K. Bhatanagar, H. Sharma and O. P. Verma. 2007. Three new diseases of *Aloe barbadensis* Mill. J. Mycol. Pl. Pathol. 37(1): 124-125.

Mandal, K. and K. A.Geetha. 2001. Floral infection of downey mildew of isabgol. J. Mycol. Pl. Pathol. 31(3): 355-357.

Mandal, K., S. Maiti, D.R. Saxena and M.Saxena. 2004. A new leaf spot disease of safed musli. J. Mycol. Pl. Pathol. 34(1): 162-163.

Mandvi Singh and R. P. Singh. 2005. Management of mushroom pathogens through botanicals. Indian Phytopath. 58(2): 189-193.

Mayee, C.D. and V. V. Datar. 1986. Phytopathometry, Tech. Bull. I, Marathwada, Agric. Univ. Parbhani.

Meenu Gupta and R. C. Garg, 2002.Epidemiological studies on ripe fruit rot of chilli caused by *Colletotrichum capsici* (Syd.) Butler and Bisby.Indian J. Hill Farming. 15(1): 126.

Monteiro, F. T. and R.W. Barreto, 2002. *Curvularia andropogonis* : the causaing agent of foliage blight of lemon grass. Fitopatologia Brasileira. 27(2): 227-231.

Naik, M. K., P. C. Hiremath, R. K. Hegde and B. M. Reddy. 1987. Anthracnose of betelvine and its incidence in Karnataka. Curr. Res. 16(12): 11-12.

Naik, M. K., P. C. Hiremath and R. K. Hegde. 1990. Effect of environmental factors on the incidence of anthracnose of betelvine. Curr. Res. 19: 174-175.

Naseema A. and K. I. Wilson. 1991. New record of fungi on some medicinal plants from India. Indian Phytopath. 43(4): 595.

Pandey, G. N. and K. B. Nigam, 1985. Annual Workshop. All India Co-ordinated Project on Medicinal and Aromatic Plants, Bangalore, 22-25 dec.

Pandey, G. N. 2005. Assessment of yield loss by fasiculated root rot and wilt. A new disease of Safed musli (*Chlorophytum borovilianum).* J. Mycol. Pl. Pathol. 35(3) : 492.

Pandya, J. R., D. M. Joshi and A. N. Sabalpara, 2009. Evaluation of Phytoextracts and Organic extracts against *Fusarium solani.* J. Pl. Dis. Sci. 4(2): 180-182.

Panse, VG and PV Sukhatme ,1967. Statistical methods for agricultural workers, 2nd Ed. New Delhi, ICAR, Publication.

Parihar Pradeep and A. Bohra. 2002 Screcap of some form for their antimicrobial activity against *Salmonella typhi.* Ad. Plant Sci. 15: 365-367.

Patel, D. J. and S. J. Patel. 1984. Senna an additional host of *Macrophomina phaseolina* in Gujarat. Indian J. Mycol. Pl. Pathol. 14: 293.

Patil, M.R. 1995. Studies on root rot diseases of Vetiver grass caused by *Sclerotium rolfsii.* Ph.D. Thesis (unpub.), Dr. PDKV, Akola.

Patni, C. S., S. J. Kolte and R. P. Awasthi. 2005. Efficacy of botanicals against *Alternaria* blight (*Alternaria brassicae)* of mustard. Indian Phytopath. 58(4): 426-430.

Paul, Y. S. and L. N. Bhardwaj. 1992. Phyllosticta leaf spot of *Glycyrrhiza glabra* linn. A New disease from India. Indian Forester. 118: 301-302.

Pillai, S. N. and K. D. Patel. 1982. Leaf spot of senna. A new record. Indian J. Mycol. Pl. Pathol. 25 : 54.

Prasad S. M. and M. K. Barnwal. 2004. Evaluation of plants extracts in management of *Stemphylium* blight of onion. Indian Phytopath 57(1): 110-111.

Rai, M. K. 1992. A new disease of *Plumbago zeylanica*. Ancient Science of Life. 11(3): 131-132.

Raj, T. S., D. J. Christopher, S. U. Rani and R. Udhayakumar, 2009. Effect of plant products on the incidence and yield parameters of chilli fruit rot. Advances Pl. Sci. 22(1): 31-32.

Rakholiya, K. B., K. K. Chheladiya, A. M. Parakhia and B. K. Kikani. 2003. Root rot of Isabgol. Indian Phytopath. 56(4): 503.

Rashmi Dubey and A. K. Pandey. 2007. *Ravendia aloii* sp. Nov- A new rust pathogen at *Aloe vera* in plains of India. J. Mycol. Pl. Pathol. 37(3):495-498.

Renubala, K. and P. K. Dutta. 1991. Factors influencing anthracnose disease of betelvine. New Agriculturist 2(2): 129-132.

Roy, A. K. 1976. Some new records of fungi on medicinal plants. Current Sci. 45: 464-465.

Sankarasubramanian Harish, Duraiswamy Saravanakumar, Ramalingam Radjacommare, E. G. Ebenezar and K. Seetharaman, 2008. Use of plant extracts and biocontrol agents for the management of brown spot disease in rice. BioControl. 53(3) : 555-567.

Sathyarajan, P. K. and A. Naseema. 1985. Piper longum. A new host record for *Colletotrichum gloeosporioides*. Curr. Sci. 54(13): 637.

Sato, T. and H. Ohkubo, 1990. Newly discovered leaf blight of citronella grass caused by *Curvularia andropogonis* in the Philippines. Japan Agricultural Research Quaranterly. 23(3): 170-175.

Sattar A., M.Alam, Abdul-Khaliq, R. S.Shukla and Suman P. S. Khanuja. 2006. First report of a leaf blight disease of *Chlorophytum borivilianum* caused by *Colletotrichum capsici* in northern India J. Mycol. Pl. Pathol. 32(1): 31-34.

Sharma, A. D. 1978. Collar rot and blight of *Ocimum* species in India. J. Mycol. And Pl. Pathol. 11(1): 149.

Sharma, S. S. and R. K. Samota. 2007. Some new fungal diseases on *Aloe barbadensis* Mill. Indian Phytopath 60 (2): 277.

Sheikh, R. Ahmed. and J.P. Agnihotri, 1977. Antifungal activity of some plant extract. Indian J. Mycol. and Pl. Pathol. 7(1):180-181.

Shivpuri, A., O. P. sharma and S. L. Jhamaria. 1997. Fungitoxic properties of plant extract against pathogenic fungi. J. Mycol. Pl. Pathol. 27: 29-31.

Shreemali J. L. 1972. Two new pathogenic fungi causing diseases on Indian medicinal plants . Indian J. Mycol. Pl. Pathol. 2: 85-86.

Shukla, R. S., S. Kumar, H. N. Singh and K. P. Singh.1993. First report of aerial blight of *Coleus forskolii* caused by *Rhizoctonia solani* In India. Pl. Dis. 77: 429.

Shukla, R. S.; M. L. Gupta and H. N. Singh, 2001. *Botryodiplodia theobromae* on Mentha arvensis – causing stem blackning and rot, a new diseases from India. J. Mycol. Pl. Pathol. 31(3): 395-396.

Singh H. B., A. Singh, A. Tripathi, S. K. Tiwari and J. K. Johri. 2008. Collar rot of *Chlorophytum borivilianum* caused by *Corticium rolfsii*: a new disease. EPPO Bulletin 31(1): 112-113.

Singh, H. B., M. L. Gupta, A. Pandey, A. Kolra and S. P. Singh. 1996. A new leaf blight of senna caused by *Alternaria cassia*. Indian J. Pl. Pathol. 14: 71-72.

Singh, N., R. R. Ahir, O. P. Verma. 2006. *Alternaria* leaf disease of two medicinal plants. J. Mycol. Pl. Pathol. 36(1): 14.

Singh, Narendra, O. P. Verma and Lalesh. Kumari. 2006 Occurrance and Symptomatology of *Alternaria* blight of *Adhatoda vasica*. J. Mycol. Pl. Pathol. 36(1): 58.

Singh, B. 1993. *Curcuma zedoaria* (Roxb) A new host for *Colletotrichum*. Indian J. Mycol. Pl. Pathol. 23(2): 220.

Sinha, A. K., K. P. Verma, K. C. Agarwal, N. K. Tooray and M.P. Thakur, 2004. Antifungal activity of different plant extract against *Colletotrichum capsici*. Advances in Pl. Sci. 17(1): 337-338.

Sreelatha R. and G. Bagyanarayana. 2008. Biocontrol Efficacy of botanicals on anamorphic fungi. J Mycol. Pl. Pathol. 38(3): 647-649.

Sumangala, K., M. B. Patil, V. B. Nargund and G. Ramegowda, 2008. Evaluation of fungicides, Botanicals and Bioagents against *Curvularia lunata*, A causal agent of gain Discolouration in rice. J. Pl. Dis. Sci. 3(2): 159-164.

Tekade, A., M. Koche and B. T. Raut. 2009. Influenced weather factor on fungal diseases of musli. J. Pl. Dis. Sci. 4(2): 173-175.

Thakur, R. N., K. P. Singh and A Husain. 1974. *Curvularia* leaf spot of Japanese mint in India. Indian J. Mycol. Pl. Pathol. 4: 199.

Theerthgiri, A. R. B., 2009. Exploitation of plant products and bioagents for eco-friendly management of chilli fruit rot disease. J. Pl. Prot. Res. 49(2): 195-203.

Varadarajan, P. H. 1966. Leaf spot and premature defoliation of *Rauvolfia serpentina* under cultivation caused by *Curvularia lunata*. Indian Phytopath. 19 : 298-300.

Verma, Kalp and Shyam Sunder Sharma. 2007. Effect of root rot of safed musli (*Chlorophytum borivilianum)* on saponins content and its management. J. Mycol. Pl. Pathol. 37(3): 644.

Verma, O. P., R. B. L. Gupta and A. Shivpuri. 2008. A new host for *Pithomyces chartarum*, the cause of a leaf spot disease on *Withania somnifera*. Plant Pathology. 57(2): 385.

Verma, Prakash, Manjulata Upadhyaya, Nisha Suyal and Hema Joshi. 2007. A new record of leaf spot of Safed musli caused by *Alternaria alternata* in Kumaun Himalayas, Uttarkhand. Indian J. Mycol. Pl. Pathol. 37(2): 381.

Verma, V.C. and Kharwar, R.N. (2006). Efficacy of neem leaf extract against it's own fungal endophyte *Curvularia lunata*. Journal of Agricultural Technology 2(2): 329-335.

Vincent, J. M. 1927. Distoration of fungal hyphae in presence of certain inhibitors. Nature. 15: 850.

Watve, Y. G., M. P. Diwakar, J. J. Kadam, U. K. Sawant and V. G. Mundhe, 2009. Effect of different Chemicals, Plant extract and Bioagent against *Colletotrichum gloeosporides* causing leaf spot disease of Jatropha. J. Plant Disease Science. 4(2): 199-203.

Yadav, R. P. 1986. Studies on antifungal properties of certain plant extracts. M.Sc. (Agri.) Thesis MPAU, Rahuri.

Yadav, S. C. and H. N. Gour. 2007. Management of leaf stripe of Barley caused by *Drechslera graminea* using Fungicides, Botanicals and Bioagents. J. Mycol.Pl. Pathol.37(3) : 457-459.

Yadav, H. L., S. K. and A. R. Saxena. 2009. Evalution of plant extracts against *Colletotrichum falcatum*. Ann. Pl. Protec. Sci. 17 (2): 459-526.

Yashoda R. Hegde, R. Ammajamma, C. K. Venugopal, S. Ashoka and T. L. Chavhan. 2009. Novel approaches for management of wilt complex of *Coleus forskohlii* (Wild.) Briq. Technical Bulletin-8, Department of Plant Pathology, University of Agricultural Sciences, Dharwad, 580005, Karnataka, India. 30pp.

VITA

1. Name of student : **Borekar Kirti Chintamanrao**
2. Date of Birth : 21st June 1986
3. Name of the College : Post Graduate Institute,
   Dr. Panjabrao Deshmukh
   Krishi Vidyapeeth, Akola
4. Residential Address : At Post - Anjangaon Surji,
   Tal. - Anjangaon Surji,
   Dist. Amravati (M.S.)
   PIN - 444 705.
5. Academic Qualification :

Sr. No.	Name of Degrees awarded	Year in which obtained	Division/ Class	Name of awarding University	Subjects
1.	B.Sc. (Agri.)	2008	First Class	Dr. PDKV, Akola	Agriculture and allied subjects

6. Research papers published (if any) : - NIL
7. Field of Interest (in which you desire to work) : Research and Lectureship

Place : Akola
Date : 31/05/2010

Signature of Student

APPENDIX I

Weekly Weather data for the year 2009 recorded at Meteorological Observatory Department of Agronomy Dr. PDKV., Akola

Actual : 2009; Normal : 1971-2010

Weeks	Dates	T MAX (°C)		T MIN (°C)		BSH (hrs)		WS (km/hr)		RH I (%)		RH II (%)		Evap (mm)		RF (mm)		CRF (mm)	Rainy Days	
		N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A		N	A
	2009																			
1	1-7 Jan	29.0	30.3	10.3	13.7	8.7	3.8	4.9	1.6	78	65	30	29	4.2	4.4	1.7	0.0	0.0	0.2	0.0
2	8-14	29.2	31.0	11.3	16.9	8.6	3.8	6.3	2.1	71	75	30	33	4.5	4.8	3.4	0.0	0.0	0.2	0.0
3	15-21	29.9	31.6	11.6	15.0	8.9	5.9	5.4	2.5	69	59	28	21	4.8	6.1	0.9	0.0	0.0	0.1	0.0
4	22-28	30.8	33.6	11.8	14.0	9.1	7.0	5.5	1.2	67	56	27	19	5.2	5.9	1.1	0.0	0.0	0.2	0.0
5	29-4 Feb	31.1	34.8	12.1	15.9	9.3	7.2	5.8	1.8	61	49	25	16	5.6	6.3	2.8	0.0	0.0	0.2	0.0
6	5-11	31.3	34.4	11.9	16.7	9.1	6.4	5.6	2.7	59	43	23	17	5.9	6.8	4.9	0.0	0.0	0.4	0.0
7	12-18	32.5	33.5	13.4	15.7	9.4	4.8	6.1	1.7	56	44	22	18	6.6	6.6	0.1	0.0	0.0	0.0	0.0
8	19-25	33.0	36.4	13.8	20.7	9.5	5.7	6.5	2.5	57	41	22	18	7.3	8.5	3.3	0.0	0.0	0.5	0.0
9	26-4 Mar	34.7	38.1	14.8	19.0	9.6	8.6	7.0	3.2	50	41	17	16	8.1	9.4	3.4	0.0	0.0	0.3	0.0
10	5-11	36.1	37.9	16.7	21.0	9.6	7.7	6.8	3.8	44	34	18	18	9.0	10.4	2.1	0.0	0.0	0.3	0.0
11	12-18	37.3	36.7	17.5	20.9	9.6	6.7	6.9	4.2	42	41	17	22	9.5	9.5	2.5	0.8	0.8	0.3	0.0
12	19-25	38.5	38.2	18.3	21.2	9.6	7.7	6.9	4.5	37	34	13	14	10.5	10.7	0.3	1.5	2.3	0.1	0.0
13	26-1 Apr	39.0	39.6	19.7	22.3	9.6	8.8	7.6	4.1	36	28	15	14	11.3	11.7	2.9	0.0	2.3	0.3	0.0
14	2-8 Apr	40.1	41.1	21.1	23.4	9.8	6.9	7.9	2.1	36	28	15	21	11.7	11.3	0.6	0.0	2.3	0.1	0.0
15	9-15	40.8	40.6	22.5	21.8	9.9	8.9	9.3	3.7	34	26	12	16	13.4	12.1	0.3	0.0	2.3	0.1	0.0
16	16-22	41.7	43.4	23.5	26.7	10.2	8.5	9.1	5.7	34	26	14	12	13.7	15.9	0.3	0.0	2.3	0.0	0.0
17	23-29	42.1	43.0	24.8	24.7	10.1	8.9	10.2	6.2	37	24	14	9	14.4	14.1	0.0	0.0	2.3	0.1	0.0
18	30- 6 May	42.7	44.9	26.0	28.8	9.9	8.9	11.4	8.5	38	30	14	12	15.4	17.3	0.3	0.0	2.3	0.2	0.0
19	7-13	42.6	43.2	26.5	29.2	10.1	9.0	12.7	11.2	43	34	17	13	16.4	18.4	0.3	0.0	2.3	0.1	0.0
20	14-20	42.6	41.8	27.3	26.9	9.7	7.8	14.6	10.5	48	58	18	27	17.3	14.1	1.8	21.8	24.1	0.2	2.0
21	21-27	42.4	41.7	27.4	28.3	9.8	6.5	15.7	11.1	50	57	20	26	17.0	13.8	4.1	20.3	44.4	0.5	2.0
22	28-3 Jun	41.9	41.7	27.6	28.6	9.7	6.3	16.2	15.3	56	51	23	25	16.3	17.8	5.7	0.0	44.4	0.5	0.0
23	4-10	39.0	39.8	25.8	28.3	8.0	4.6	14.9	16.8	62	56	30	31	13.4	17.2	18.3	0.0	44.4	1.2	0.0

24	11-17	38.2	41.6	25.5	28.9	7.5	7.2	15.4	15.5	71	55	42	27	11.1	17.6	43.3	0.0	44.4	2.0	0.0
25	18-24	35.3	40.8	24.9	27.0	7.1	5.3	15.1	13.3	76	60	50	28	9.1	14.4	52.3	2.4	46.8	2.2	0.0
26	25-1Jul	34.1	33.6	24.2	24.5	5.3	3.6	13.4	9.2	80	82	55	59	7.3	7.8	38.2	143.2	190.0	2.3	4.0
27	2-8	33.5	32.8	24.4	24.5	5.2	3.7	12.9	4.1	81	90	58	65	6.8	4.7	34.7	77.1	267.1	2.4	5.0
28	9-15	32.3	30.2	23.7	24.1	3.8	1.4	12.0	7.5	84	89	62	71	5.5	3.4	52.2	48.0	315.1	2.8	4.0
29	16-22	32.0	28.6	23.9	23.6	3.3	1.2	11.2	4.9	84	86	65	78	5.6	3.1	58.6	57.2	372.3	2.6	3.0
30	23-29	31.7	30.3	23.3	23.6	4.3	3.1	11.9	4.3	85	85	64	60	5.3	4.0	44.2	30.0	402.3	2.6	4.0
31	30-5 Aug	31.1	32.2	23.1	24.0	3.6	3.4	11.7	7.5	88	81	66	52	4.6	5.9	49.3	0.0	402.3	2.5	0.0
32	6-12	30.2	32.1	22.9	24.0	3.5	2.3	11.6	7.2	87	84	69	56	4.2	4.8	59.9	4.2	406.5	2.9	0.0
33	13-19	30.5	32.8	22.8	24.9	4.4	3.7	11.7	7.7	86	77	66	49	4.5	6.3	40.6	0.0	406.5	2.2	0.0
34	20-26	30.5	31.1	22.6	22.8	4.3	2.5	11.0	4.2	88	94	66	73	4.3	3.8	46.7	65.7	472.2	2.0	3.0
35	27-2 Sep	30.4	30.2	22.7	23.5	4.4	2.8	10.6	6.5	86	91	64	68	4.2	3.5	47.1	2.9	475.1	2.4	0.0
36	3-9	31.1	30.3	22.5	23.3	5.7	3.2	9.1	10.1	85	93	61	67	4.7	4.0	28.5	30.2	505.3	1.5	1.0
37	10-16	32.2	33.2	22.4	22.9	7.1	5.4	9.0	6.0	85	85	56	43	5.1	5.2	18.9	0.0	505.3	1.1	0.0
38	17-23	33.4	35.2	22.3	22.8	7.2	7.1	8.5	2.7	83	81	53	34	5.3	5.7	24.6	2.1	507.4	1.4	0.0
39	24-30	33.7	34.3	21.9	24.5	7.6	5.6	5.4	5.5	83	83	50	49	4.9	6.5	24.4	6.8	514.2	1.5	2.0
40	1-7 Oct	33.9	32.2	20.2	23.7	8.1	4.1	7.5	4.3	81	90	45	60	5.5	4.3	21.8	67.8	582.0	1.1	4.0
41	8-14	34.1	32.9	18.7	19.8	4.2	8.1	4.1	4.4	76	90	40	33	5.3	5.1	16.0	0.0	582.0	0.9	0.0
42	15-21	33.9	34.9	18.1	17.8	8.4	7.8	4.4	1.5	74	81	36	23	5.5	5.7	3.1	0.0	582.0	0.4	0.0
43	22-28	33.1	33.8	18.5	14.7	8.4	6.7	4.1	1.6	73	74	36	19	5.3	5.6	10.0	0.0	582.0	0.6	0.0
44	29-4 Nov	33.0	34.4	15.8	14.3	8.7	6.8	4.7	1.6	72	70	31	17	5.3	6.4	2.3	0.0	582.0	0.3	0.0
45	5-11	32.4	31.0	14.8	19.1	8.6	4.1	4.5	2.1	70	81	30	50	5.2	4.9	3.7	5.0	587.0	0.3	1.0
46	12-18	31.7	29.3	13.7	21.7	8.6	3.6	4.6	1.6	70	92	30	58	4.9	3.5	1.1	97.8	684.8	0.2	3.0
47	19-25	31.0	27.5	13.1	13.1	8.6	7.9	4.4	1.1	71	89	30	35	4.6	3.8	10.1	0.0	684.8	0.3	0.0
48	26-2 Dec	30.3	28.8	12.4	12.2	8.8	7.2	4.6	1.3	71	82	31	29	4.3	4.0	6.8	0.0	684.8	0.3	0.0
49	3-9	29.8	29.6	11.2	13.5	8.7	5.4	4.7	1.0	70	85	29	33	4.3	3.5	1.3	0.0	684.8	0.2	0.0
50	10-16	29.4	30.5	10.3	15.1	8.8	4.9	4.5	0.8	70	88	27	34	4.2	3.4	1.3	0.0	684.8	0.2	0.0
51	17-23	29.5	29.0	10.6	14.7	8.7	5.1	4.7	2.1	69	86	29	36	4.3	3.3	0.9	0.7	685.5	0.1	0.0
52	24-31	29.2	27.4	10.7	12.2	8.6	4.8	4.8	1.7	70	76	31	33	4.3	3.8	2.6	14.0	699.5	0.2	1.0