

**MANAGEMENT OF POWDERY MILDEW OF  
GREEN GRAM**

THESIS

149918

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  
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Enrolment Number - AA/535

2009

14/10/09

## DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled "**MANAGEMENT OF POWDERY MILDEW OF GREEN GRAM**" or part thereof has neither been submitted for any other degree or diploma at any university, nor the data have been derived from any thesis / publication of any university or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.



Rakhonde

Place: Akola

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Date: 10/06/2009

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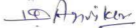


## CERTIFICATE

This is to certify that the thesis entitled "**MANAGEMENT OF POWDERY MILDEW OF GREEN GRAM**" submitted in partial fulfillment of the requirements 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 Rakhonde Prashant Ninaji under my guidance and supervision. The subject of the thesis has been approved by the student's Advisory Committee.

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(Rakhonde Prashant Ninaji)

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(D)

## List of Abbreviations

%	- Per cent
/	- per
@	- at the rate of
°C	- Degree Celsius
CD	- Critical difference
cm	- Centimeter
DAS	- Days after sowing
<i>et al.</i>	- et alia (and other)
Fig.	- Figure
g	- Gram
H <sub>2</sub> SO <sub>4</sub>	- Sulphuric acid
ha	- Hectare
i.e.	- that is
kg	- Kilogram
m	- Meter
mg	- Milligram
ml	- Milliliter
N	- Nitrogen
No.	- Number
NS	- Non significant
PDC	- Per cent disease control
PDI	- Per cent disease intensity
q	- Quintal
SE(m) ±	- Standard error of mean
Sig.	- Significant
T	- Treatment
Var.	- Variety
viz.,	- Namely

(F)

## THESIS ABSTRACT

- a. Title of the Thesis : "MANAGEMENT OF POWDERY MILDEW OF GREENGRAM
- b. Name of student : Prashant Ninaji Rakhonde
- c. Name and Address of Major Advisor : Shri. D.G. Anvikar  
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- d. Degree to be awarded : M.Sc. (Agri.)
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- f. Major subject : Plant Pathology
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## ABSTRACT

Green gram (*Vigna radiata* L. wilczek) is an important short duration crop, it ranks second in nutritive value. Powdery mildew caused by *Erysiphe polygoni* DC is major destructive fungal disease and cause severe yield losses.

Present studies were therefore undertaken to study the effect of weather parameters, alteration of sowing dates and manage the disease with fungicides, plant extracts and bioagent.

First initiation of the disease was appeared in 31<sup>st</sup> meteorological week in the field. Weather factors maximum temperature (27.8 to 32.5<sup>o</sup>C), minimum temperature (22.6 to 24<sup>o</sup>C). Morning relative humidity (85 to 94%) and evening (56 to 70%) wind velocity 4.1 to 4.3 km/hrs, rainfall of 27.6 mm and sunshine hours ( 4.3 to 5.0) were found favourable for the disease development.

*In vitro* 25 to 30<sup>o</sup>C temperature, 80 to 90% RH and 24 hr light period was found favourable for germination of conidia.

Least disease intensity 27.99% was recorded in early sowing i.e. 1<sup>st</sup> July however intensity was maximum in delayed sowing. Highest yield 750 kg/ha was recorded in early sowing date i.e. 1<sup>st</sup> July 2008 however least yield (251.38 kg/ha) was recorded in crop sown at 22<sup>nd</sup> July.

*In vitro* tridemorph (0.05%) recorded higher (85.11%) inhibition of spore germination. Behada 5% extract inhibited 66.45% spore germination. Culture filtrate of *Pseudomonas fluorescens* inhibited 63.93% spore germination.

Maximum disease reduction was observed in diphenconazole (69.11%) and tridemorph (69.11%). In plant extract maximum 57.22% disease reduction observed in behada extract. Bioagent *Pseudomonas fluorescens* showed 51.22% reduction of disease.

Maximum yield was obtained in treatment penconazole 0.05% (555.55 kg/ha). Highest number of pods/plant (17.27) were recorded in penconazole whereas pods weight/5 plant and grain weight/5 plant were maximum in propiconazole.

Among 35 variety three varieties viz.,BPMR-48, BPMR-146, BPMR-207 found highly resistant to powdery mildew disease.

# CHAPTER I

## INTRODUCTION

### 1.1. Background information

Green gram (*Vigna radiata* (L.) Wilczek) is one of the most important pulse crop in India comes under family leguminosae. Green gram is also known as mung bean, mash bean, muggo or monggo, golden gram and green soy. It is excellent source of high quality protein. Importance of this crop among other pulses is due to its nutritional value, short duration, adaptability to all seasons and suitability to various cropping system.

Green gram is highly nutritious containing 24 per cent protein, 13 per cent fats, 56.6 per cent carbohydrates and 3 per cent dietary fibres, it is rich in minerals having 140 mg calcium, 8.4 mg iron and 280 mg phosphorus. It also contains 0.47 mg vit. B<sub>1</sub>, 0.39 mg Vit. B<sub>2</sub> and 2 mg niacin, sprouted seeds contains Vit. C also. Whole or split seed of green gram is rich source of folate, copper, zinc and selenium, it is particularly rich in amino acids such as leucine, phenylamine, lysine, valine, isoleucine etc. it has calorific value of 334 calories per 100 g of edible protein (Baldev *et al.*, 2003).

Green gram is a native of India and Central Asia. Green gram is widely cultivated throughout the Asia including India, Pakistan, Bangladesh, Shrilanka, Thailand, Cambodia, Vietnam, Indonesia, Malaysia, South China and Formosa.

In India green gram cultivated in Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Bihar, Rajasthan, Kerala and Tamil Nadu. Maharashtra is the largest producer according nearly 23.05 per cent of the total production while the productivity is highest in Kerala i.e. 824 kg ha<sup>-1</sup>.

In India during year 2006-07 it was grown on an area of 27.69 lakh ha with annual production of 12.3 lakh tonnes (Anonymous, 2007). In Maharashtra, it is grown on an area of 6.62 lakh ha with annual production of 3.51 lakh tonnes and productivity of 550 kg/ha. Area under the crop in

Vidarbha region was 3.09 lakh ha with production of 0.69 tonnes (Anonymous, 2007).

## 1.2 Importance of study

Mungbean crop can be attacked by more than 50 pathogens, that includes fungi, bacteria, virus etc. causing diseases in plant. Some of the major fungal diseases are reported by several workers, such as powdery mildew, root rot and different leaf spot caused by *Cercospora* spp., *Colletotrichum* spp., *Macrophomina phaseolina* (Nath *et al.*, 1970), Shukla and Bhargava (1976).

However low productivity to some extent is due to powdery mildew disease caused by *Erysiphe polygoni* DC. as it is most devastating disease of mungbean. Sometimes, the cultivators cant harvest a single grain.

In addition to mung, the fungus parasitizes several other leguminous crops like urdbean (*Vigna mungo*), cowpea (*Vigna sinensis*) and field pea (*Pisum sativum*) etc.

Powdery mildew caused by *Erysiphe polygoni* DC. is one of the serious disease occurring on mungbean in India, it appears in epidemic form, late in season, almost every year with varying intensities and results in premature defoliation, drying of foliage and forced maturity of infected plants leading to heavy losses in grain yield.

The fungus is an ectophytic, spreading on the surface of host and sending haustoria into the epidermal cells. The conidiophores arise vertically from the superficial hyphae on the host surface. Each conidiophore bears several spores in chain. Conidiophores are septate and hyaline. The conidia or oidia are elliptical, barrel shaped, hyaline, unicellular and thin walled.

## 1.3 Objectives of the study

Except some reports, not much work has been done on epidemiological and management aspects of powdery mildew. The present investigation was made on some of the aspects of the disease, keeping in view the relative damage caused.

The objectives of studies were :

- i. To know the effect of weather factors on incidence of powdery mildew of green gram.
- ii. To study the effect of sowing dates on occurrence of powdery mildew.
- iii. Management of disease using chemical and biocontrol agents.

#### **1.4 Scope and limitations**

Being devastating disease of green gram powdery mildew reduces the yield of grain. It is necessary to generate information on the epidemiology i.e. environmental condition which increases disease i.e. temperature, humidity and also management of disease.

Secondly shifting of sowing date according to environmental condition is an appropriate method to escape the crop from disease infection and there by different sowing dates were tried to observe the severity of disease.

#### **1.5 Hypothesis**

Powdery mildew of green gram appears in epidemic form every year. Date of sowing play an important role in appearance of the disease this was taken in to consideration and different dates of sowing were scheduled to see their role in disease escape mechanism.

In management of the disease by chemicals, plant extracts and bioagent, calixin and sulphur are found to be the best fungicides for management of the disease, however addition of trizoles and comparison of may be useful for management of the disease. In addition plant extracts and bioagent are also found promising in management of the disease in ecofriendly manner. This has included in this experiment to test their effectiveness.

## CHAPTER II

### REVIEW OF LITERATURE

#### 2.1 Powdery mildew symptoms and morphology of fungus

Yarwood (1957) reported stunting, distortion and premature leaf fall due to infection of *Erysiphe polygoni* causing powdery mildew disease in pulses. The fungus, is an obligate parasite, initially infects young primary leaves heavily, finally leading to chlorosis (yellowing) and necrosis.

Sankhla *et al.* (1967) studied morphology of *Erysiphe polygoni* and noted that the fungus produces amphigenous dirty white, hyaline mycelium and barrel shaped granular conidia, measuring 32.58 x 15.59  $\mu\text{m}$ .

Hans and Boesewinkel (1980) measured conidial size of *Erysiphe polygoni* infecting green gram as 38.4 x 14.3  $\mu\text{m}$  and that of black gram 37 x 19  $\mu\text{m}$ .

Raut *et al.* (1986) recorded powdery growth of *E. polygoni* on stem and leaves of green gram and black gram at flowering. Severe infection of inflorescence was found to affect pod setting adversely.

Raguchander *et al.* (1998) observed higher incidence of black gram powdery mildew at vegetative stage compared to maturity stages. At vegetative stage, the average incidence ranged from 4.2 to 38.0 per cent while at pod maturity stage, from 4.8 to 32.8 per cent.

Mandhare *et al.* (2008) they observed powdery mildew of soybean caused due to *Erysiphe polygoni*. The incidence of powdery mildew was noticed from flowering to pod formation stage. Initially small patches of white powdery mass developed on both the surface of leaves thereafter the patches grew and covered a large area and affected leaves turn purple. The disease occurred on leaves (65 DAS) in the second week of september infection was noticed on young leaves, branches, stem and pods.

## 2.2 Aerobiology and Epidemiology

Yarwood (1936) reported passive dissemination of conidia of *Erysiphe polygoni* DC depending on maturity of the conidia, dryness of plant and fungus surfaces and wind. Reduction in liberation of conidia at night has been predicted because of higher relative humidity and less wind.

Soloman (1951) maintained the humidity levels in desiccator by using a mixture of concentrated sulphuric acid + distilled water.

Yardwood *et al.* (1954) reported infection of powdery mildew to plants within a temperature range of 10-28°C with an average of about 21°C.

Yarwood (1957) observed favourable effect of rains, dews, fog and sprinkle irrigation on the development of powdery mildew, but little role of atmospheric relative humidity. The disease appeared more in shade than fully natural light condition.

Schnathorst (1959) noted that chains of conidia and individual conidia of powdery mildew at high relative humidity (100%) adhere to one another and prevent the detachment of chains or single conidia. However, chains of conidia formed at lower humidities (50-60%) were not found to adhere each other.

Paulech (1969) observed that minimum temperature for germination of conidia of *E. polygoni* was 7°C, optimum 25°C and maximum 33°C. The incubation period on cowpea at 25°C was 4 days. The general dynamics at appressorial formation were similar at 25°C. The appressoria begin to form 2.5 hr after the germination of conidia (3.5 – 4 hr after incubation). Germination reached its peak 3.5 to 4 hr after inoculation, while the maximum formation of appressoria occurred 6 hr after inoculation.

Singh and Singh (1981) observed both white and green light enhanced germination and elongation of germ tubes positive phototropism was induced by white light, negative by green light. On pea leaves conidial germination was 84.5% in the light and 75% in dark.

Soria and Quebral (1973) noted highest incidence of *E. polygoni* on *Phaseolus aureus* in January when monthly mean

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## INTRODUCTION

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Schnathorst (1959) noted that chains of conidia and individual conidia of powdery mildew at high relative humidity (100%) adhere to one another and prevent the detachment of chains or single conidia. However, chains of conidia formed at lower humidities (50-60%) were not found to adhere each other.

Paulech (1969) observed that minimum temperature for germination of conidia of *E. polygoni* was 7°C, optimum 25°C and maximum 33°C. The incubation period on cowpea at 25°C was 4 days. The general dynamics at appressorial formation were similar at 25°C. The appressoria begin to form 2.5 hr after the germination of conidia (3.5 – 4 hr after incubation). Germination reached its peak 3.5 to 4 hr after inoculation, while the maximum formation of appressoria occurred 6 hr after inoculation.

Singh and Singh (1981) observed both white and green light enhanced germination and elongation of germ tubes positive phototropism was induced by white light, negative by green light. On pea leaves conidial germination was 84.5% in the light and 75% in dark.

Soria and Quebral (1973) noted highest incidence of *E. polygoni* on *Phaseolus aureus* in January when monthly mean

temperature, relative humidity, wind velocity, total solar radiation and rainfall were 25.6°C, 85%, 1.8 mph, 9976 g-cal-cm<sup>2</sup> day and 1.61 inches, respectively. Planting of *P. aureus* at a time when vegetative growth does not coincide with environmental conditions favourable for powdery mildew has been suggested.

Deshpande and Dake (1978) noticed the epidemics of Erysiphales at 25°C temperature.

Agrawal and Philip (1983) recorded incidence of powdery mildew in udid (*Phaseolus mungo*) 60 days after sowing. The infection thereafter continued till harvest i.e. for 40 more days.

Paul and Kaushal (1985) based on the effect of relative humidity (RH) on conidial germination, grouped powdery mildew in 4 categories.

- A. Those requiring 70% RH e.g. *Erysiphe berberidis* and *Oidium* sp.
- B. Those requiring 70-100% e.g. *Erysiphe martii*, *E. cichoracearum*, *E. graminis*, *Spaerotheca macularis*, *S. fulginea* and *Oidium* spp.
- C. Those requiring 20-100% RH e.g. *E. cruciferarum*, *E. betae*, *E. pisi*, *Oidium amaranthi* and *O. oxalidis* and
- D. Those in different to any RH range e.g. *E. pisi* on *Vigna mungo* and *Vicia faba*.

Hsich *et al.* (1988) reported that powdery mildew (*Erysiphe polygoni*) was earlier and more severe in mungbean (*Vigna radiata*) than in Adzuki bean (*Vigna angularis*). The disease was more severe on these crops grown in autumn than those planted in the spring. Most spores were disseminated during the day, especially at noon while few were released at night. Climate data indicated that the disease was directly and indirectly influenced by environmental factors.

Saharan and Sheoran (1988) observed highest germination of conidia at 21±1°C temperature, 100% relative humidity and 36.7 to 40% more germination in light than dark condition.

Kunkaliker and Padaganur (1989) observed that for *Erysiphe polygoni* to cause powdery mildew development in mungbean minimum mean temperature 20°C and relative humidity 82.5 to 83.5% are essential.

Saxena and Saxena (1991) studied powdery mildew of mungbean caused by *Erysiphe polygoni* and found significant positive correlation of disease intensity with maximum temperature but the correlation with relative humidity and rainfall were negative.

Mittal and Sharma (1992) studied development and spread of powdery mildew of green gram and black gram in the Kumaon Hills of India and noted the disease appearance 90 days after sowing when the crop was in post flowering and pod formation stage. During this period, average maximum temperature was 28.8°C, minimum temperature 17.2°C, RH above 75% and weekly rainfall 5.8 mm spread over 1-2 days.

Abbiah (1993) recorded appearance of powdery mildew on rabi urdbean in the first week of January when the crop was 45 days old. Fast mildewing was positively correlated with maximum temperature but negatively with minimum temperature. Wind velocity showed positive correlation with disease spread.

Raguchander and Rajappan (1995) observed lower incidence of *Erysiphe polygoni* in July sown *Vigna mungo* crop than those sown in August- January. High relative humidity, maximum and minimum temperature and low rainfall favoured severe incidence of powdery mildew.

Thakur and Agrawal (1995) noted rapid development of powdery mildew on mungbean and urdbean when the average maximum temperature ranged between 27.2°C to 30.3°C, relative humidity from 67 to 90% during morning and 12 to 38% at noon and wind velocity from 2.3 to 4.1 km/h. A positive correlation was found between mildew severity and temperature and wind velocity in most of the varieties. However, the correlation with relative humidity was negative and significant except in few varieties. The pooled infection rates ( $r/\text{unit}/d$ ) on resistant *V. radiata* and *V. mungo* varieties was < 0.1 with disease score of 1.5 while in apparently slow mildewing varieties and value were also < 0.1 but showed a score of

7-9. The effect of disease levels on grain yield of *V. mungo* showed negative significant correlation but in case of *V. radiata* it was negative non significant.

Badgujar (1996) recorded in *in vitro* studies of powdery mildew of green gram that the highest germination of conidia *E. polygoni* at the rate of 25 to 30<sup>0</sup>C temperature 95% relative humidity and 12 hr light.

Saxena *et al.* (1997) observed 26±1<sup>0</sup>C mean temperature and 85.95% relative humidity as a main predisposing factors for powdery mildew development in black gram. The disease exhibited positive significant correlation with maximum temperature but a negative significant correlation with morning and evening relative humidity.

Khare *et al.* (1998) noticed that appearance of powdery mildew 32 days after sowing in a susceptible cultivar PS-16 of mungbean but in other cultivars, it initially appeared at flowering. The disease severity was positively correlated with maximum temperature in all the cultivars and with minimum temperature and/or sunshine in some cultivars. The disease significantly reduced yield in susceptible cultivar RS-16.

Gupta (2001) observed powdery mildew initiated 30 DAS at pod initiation stage (30 July – 5 August, 2000) in green gram. During this period maximum temperature was 33.8<sup>0</sup>C and minimum 23.1<sup>0</sup>C, RH 72%, sunshine 4.76 hr, wind velocity 10.6 kmph and no rains.

Bhattacharya and Shukla ( 2002) observed that per cent severity of *Erysiphe pisi* DC on *Pisium sativum*. Var. Type J-63 was studied at three sowing dates under irrigated and rainfed conditions. Severity was higher under rainfed and significantly variety under sowing dates and crop growth stages. Path analysis and per cent association estimation showed that severity is affected by minimum temperature and maximum relative humidity. Under irrigated condition, maximum severity was 37.4<sup>0</sup>C – 19.4<sup>0</sup>C, 53% to 25% and 11.8 h. while under rainfed condition it was 37.0<sup>0</sup>C – 23.8<sup>0</sup>C, 51.4% to 25% and 11.9 h for maximum temperature, minimum temperature, maximum relative humidity- minimum relative humidity and sunshine duration respectively.

Singh and Sirohi (2003) reported the effect of temperature, relative humidity, rainfall and sowing date of ontogeny of powdery mildew (*Erysiphe polygoni* DC) black gram and observed the initiation of powdery mildew occurred in 37<sup>th</sup> and 38<sup>th</sup> MW. Intensity increased after 39<sup>th</sup> MW when less rain, cooler nights and high day temperature which was enough for dew formation.

Mandhare and Surywanshi (2007) showed that conidia of *Erysiphe polygoni* did not germinate at 50% relative humidity even after 36 hrs of incubation only 0.80% conidial germination at 48 hrs of incubation, at 60% relative humidity conidia started to germinate after 18 hrs of incubation showing only 0.40% to 8.00% germination even after 48 hrs of incubation. With the increase in relative humidity from 60% onwards the conidial germination increased. Maximum conidial germination of 56.50% was recorded at 90% relative humidity at 42 hrs.

Mandhare *et al.* (2008) they showed that powdery mildew of soybean caused due to *Erysiphe polygoni*. The disease occurred on leaves (65 DAS) in second week of September. At the time of occurrence of disease the maximum temperature was 30.6<sup>o</sup>C, minimum temperature 20.7<sup>o</sup>C with relative humidity (max. 85% and min. 64%) with dry climate.

### **2.3 Effect of sowing date on disease severity**

Vinayak (1977) recorded least incidence of powdery mildew and increased yield of green gram by sowing the crop in third week of August compared to late sowing in July.

Moghe and Utikar (1981) observed minimum incidence of powdery mildew in green gram by sowing the crop in mid of August. Crop sown in late July showed maximum disease.

Sivaprakasam *et al.* (1981) found higher incidence of *Erysiphe polygoni* in *Vigna radiata* and *V. mungo* in 60 and 80 days old crop sown on 1<sup>st</sup> and 20<sup>th</sup> August as compared to 40 days old crops sown on 10<sup>th</sup> September. Similarly plants raised with wider spacing of 30 x 15 cm had a low level of disease than the plants raised from closer spacing of 30

x 10 and 30 x 5 cm compared to black gram, the disease incidence was more in green gram.

Kunkalikal and Padaganur (1991) recorded lowest percentage disease index and highest grain yield in early sown crop of green gram than late. In the late sown crop, disease developed most quickly when minimum temperature was 20<sup>0</sup>C and relative humidity 82.5 to 83.5% early sowing was thus found to reduce disease incidence and crop losses.

Thakur (1992) observed higher severity (66.84%) of powdery mildew (*Erysiphe polygoni*) on 60 days old mungbean compared to lower severity (8.76%) on 30 days old crop. Similarly, disease severity was maximum (45-67%) in sole crop of mungbean than in intercrop with sesamum and bean.

Wanjari and Raut (1994) suggested sowing of resistant or tolerant genotype of green gram in early July for better integrated management of powdery mildew in *kharif* season.

Bhakre (1995) observed that there was increase in powdery mildew of green gram as it was sown late i.e. disease was less 25<sup>th</sup> June sowing while it was increased in 10<sup>th</sup> July and 25<sup>th</sup> July sowing, regarding yield of mungbean highest grain yield was obtained in early sowing crop.

Tripathi (2001) observed that the least disease intensity (24.94%) was noticed in first date of sowing and it was increases with delay sowing of field pea.

Singh and Sirohi (2003) determine the effect of date of sowing on powdery mildew (*Erysiphe polygoni* DC) of black gram and observed initiation of disease at 37 and 38 met. week during 1997 and 1996 respectively and disease development was very low. The disease intensity increased after the 39<sup>th</sup> week when less rain, cooler nights and high day temperature, which were enough for dew formation. The disease was not observed in the crop sown in the last week of June but in the subsequent sowing. The incidence of powdery mildew increased the crop sown in last week of July recorded the highest powdery mildew incidence.

Wadje *et al.* (2008) studied effect of 4 dates of sowing on development of powdery mildew (*Erysiphe polygoni*) on greengram and results indicated that with the subsequent delay in sowing there was progressive increase in the powdery mildew intensity.

#### 2.4 Yield losses and its assessment

Uppal *et al.* (1935) observed heavy reduction in pod formation in pea due to severe infection of powdery mildew in Bombay State and further reported that even one picking was not possible whereas 6-7 pickings were obtained from a normal crop.

Vasudeva (1960) reported 23% loss in pea yield due to powdery mildew (*Erysiphe polygoni*) under field conditions.

Munjal *et al.* (1963) studied the losses caused by *Erysiphe polygoni* on pea. They described the scale of infection depending upon different disease intensities.

Grade	Description	Reaction
0	Plants free from infestation	Highly Resistant (H.R.)
1	Few plants showing traces to 10% infection on leaves, stems free from infection	Resistant (R)
2	Slightly infection with fine coating of powdery growth on leaves covering 10.1 to 25% leaf area, slight infection on stems, pods usually free	Moderately Resistant (M.R.)
3	Dense powdery coating covering 25.1 to 50% leaf area moderate infection stems, slight infection on pods	Moderately Susceptible (M.S.)
4	Dense powdery coating covering 50.1 to 75% leaf area, stem heavily and pods moderately infected, infected portion turn grayish	Susceptible (S)
5	Severe infection with dense powdery growth covering more than 75% area of the whole plant including pods, plants resulting in premature defoliation and drying	Highly Susceptible (H.S.)

Quebral and Cowell (1978) recorded upto 21% loss in yield of mungbean due to powdery mildew at Los Bahos in Phillipines.

Raut and Wangikar (1979) observed reduction of 34.50% in pod number, 42.31% in pod weight, 31.81% in size of grain and 50.84% in weight of 100 grains of pea when the powdery mildew incidence was 100 per cent.

Nawaz and Narayansamy (1983<sup>b</sup>) observed considerable reduction in shoot length, root length, nodulation and plant growth of black gram with increased disease intensity of powdery mildew caused by *Erysiphe polygoni*.

Gohil *et al.* (1988) reported average yield loss of 19.1% in cumin due to powdery mildew caused by *Erysiphe polygoni*.

Singh *et al.* (1991) recorded more than 70% yield losses in 16 out of 20 varieties of mungbean (*Vigna radiata*) due to powdery mildew. Maximum (85.70%) loss was recorded in a variety Pusa-117.

Rathi and Tripathi (1994) observed significant reduction in plant growth and yield parameters due to *Erysiphe polygoni* in pea increase in disease intensity showed corresponding decrease in plant height, number of primary branches and yield. The disease caused reduction of 28.6% in the number of pods/plant in susceptible T-163 entry when the disease intensity was 100% under natural condition.

Thakur and Agrawal (1995) studied the disease intensity of powdery mildew *Erysiphe polygoni* on mungbean and urd bean and measured with a 0-9 scale.

- O = Free of mildew colonies
- 1 = Upto 1% area covered with mildew colonies
- 3 = 1.1 to 5% area covered with mildew colonies
- 5 = 5.1 to 25% area covered with mildew colonies
- 7 = 25.1 to 50% area covered with mildew colonies
- 9 = Above 50% area covered with mildew colonies

Ayub *et al.* (1996) estimated an average loss of 29.08% in black gram due to powdery mildew. The yield contributing parameters like

number of pods/plant, number of grains/pod, 100 grain weight and grain yield were significantly higher in fungicide sprayed plants as compared to unsprayed plants.

Tripathi *et al* (2002) showed that disease intensity had a direct effect on reduction in number of pods, weight of pods and weight of 100 grains. It is increased with decrease in disease intensity. Spore trapping revealed that south direction found to be predominant source of spores as more number of spores were trapped from this direction than other directions.

## 2.5 Screening

Sivaprakasam *et al.* (1976) found none of the 22 varieties of green gram and 13 varieties of black gram were found resistant to powdery mildew (*Erysiphe polygoni*) under different inoculation in the field.

Gangadharan *et al.* (1983) found that out of 380 genotypes of mungbean screened against powdery mildew, 170 remained free of powdery mildew infection in the field. Out of the 170, 17 were resistant and 43 moderately resistant under artificial inoculation conditions in pot.

Reddy *et al.* (1987) screened 55 mungbean accessions using excised leaf techniques for powdery mildew and observed all, except 7 RUM accession susceptible to the disease. These RUM accessions showed resistant reaction even after two reinoculation and were found resistant in the field under natural powdery mildew infection.

Agrawal and Nema (1989) screened 170 mungbean (*vigna radiata*) and 85 black gram (*V. mungo*) cultivars for resistance to *Erysiphe polygoni* and found out that genotype ML-223 and ML-395 of mungbean and BG-17 of black gram most resistant to the disease under natural infection in the field.

Patil *et al.* (1989) found that out of 40 cultivars of green gram (*V. radiata*) only one cultivar BGG-1 showed moderately resistant, 2 moderately susceptible and remaining all highly susceptible to powdery mildew infection in the field.

Hartman *et al.* (1993) they found that out of 4000 accessions of mungbean the global opment center Taiwan, screened for resistance to powdery mildew and *Cercospora* leaf spot and observed few line were rated highly resistant to powdery mildew over several, years, but other were rated moderately resistant or susceptible in other years.

Laksmipathi *et al.* (1993) evaluated disease severity of 45 *Vigna radiata* gentyopes to powdery mildew incidence. Among these, only one genotypes 'ML-3' was moderately susceptible,30 were susceptible and 14 highly susceptible.

Patil and Moghe (1993) tested reaction of 10 varieties of mungbean (*V. radiata*) and 10 of urd bean(*V. mungo*) against powdery mildew under natural field conditions and found 4 varieties each of mungbean and urdbean highly resistant to the disease.

Reddy *et al.* (1994) reported that powdery mildew resistance in mungbean is governed by two dominant genes designated as Pm1 and Pm2 presence of both genes in a variety show resistant reactions. Presence of Pm1 give R1 and Pm2 give R2 resistant reactions, whereas absence of these genes R3, R4 and R5 susceptible reactions.

Pawar *et al.* (1995) observed only TARM-18 out of 50 cultivars of *V. radiata*. Completely resistant to *Erysiphe polygoni* but none of the 50 *Vigna mungo* cultivars were resistant to powdery mildew fungus. The disease incidence in susceptible cultivar was 70-95%.

Khare and Lakpale ( 1997) evaluated 19 mungbean lines for field resistance to powdery mildew and identified TARM-1, TARM-2, TARM-13, TARM-21, TARM-22, TARM-26 and WGG-47 as moderately resistant to powdery mildew based on reaction of susceptible check PS-16.

Wangpiyasatid *et al.*(1999) observed resistance to powdery mildew, *Cercospora* leaf spot and cowpea weevil incidence in 10 mungbean mutants which were treated with gamma rays and ethyl methane sulphonate and tested under artificial inoculations in greenhouse. The tested mutant lines showed potential for development into new varieties viz., MS-10 and MS-25 for resistance to powdery mildew.

Gupta (2001) out of 67 entries of green gram none of totally resistant to powdery mildew. Six entries viz., TARM-2, AKM-9242, TARM-18, PM-9338, AKM-9902 and BPMR-145 exhibited resistant reaction to the disease and 9 moderately resistant, 35 moderately susceptible and 13 susceptible and four entries viz., Kopergaon, NM-92, VC-3960-88 and VC-6372-64 proved highly susceptible.

Kunkalikar and Padaganur (2002) out of ninety cultivars of green gram only three genotypes viz., black green gram, Cob-g-Co-4 and Bgg-2 were resistant showing an average grade of three and 26 to 50 per cent disease index. Sixty-nine cultivars were moderately susceptible with an average grade four and 51 to 75 per cent disease index.

Mandhare and Suryawanshi (2008) total 82 green gram genotypes were screened against powdery mildew (*Erysiphe polygoni*) and yellow mosaic virus (MYMV). The green gram genotypes Vaibhav, BPMR-145, TARM-18, Phule M-2001-3 and Phule M-2001-5 exhibited combined resistant against powdery mildew and yellow mosaic virus.

## **2.6 Management of powdery mildew by chemical, plant extract and bioagent**

Mathur *et al.* (1971) obtained effective control of *Erysiphe polygoni* of urd by spraying elosal followed by thiovit. However, yield was maximum with Thiovit.

Gupta *et al.* (1976) found Cosan gave very good control of disease while elosal and karathane W.D. proved to be the most potent fungicides in checking the disease following by thiovit, moresan and morocide. There was no significant difference in incidence of disease between Aureofungin and control treatments. Karathane W.D. Elosal and Thiovit were superior in reducing disease incidence and enhancing grain yield.

Srivastava *et al.* (1973) found elosal, karathane, cosan and thiovit were effective in control powdery mildew of pea.

Kotasthane and Agrawal (1976) found effective check of mungbean powdery mildew with sprays of Bavistin and Benomyl. Dithane Z-78 was not effective. Bavistin also significantly improved 100 seed weight.

Khatua *et al.* (1978) obtained 70% control of powdery mildew (*Erysiphe polygoni*) of local pea by spraying calixin (tridemorph) twice at fortnightly interval at 0.4 l a.i./ha. karathane (dinocap) at 0.45 l a.i./ha was the next best fungicide to control the disease (62.66%) milstem, sulfil, aureofungin, morocide and macuprox also gave encouraging results.

Singh and Naik (1977) found maximum control of *Erysiphe polygoni* causing powdery mildew of *Phaseolus mungo* with calixin followed by bavistin, benlate and thiovit.

Vinayak (1977) observed effective control of powdery mildew of green gram by dusting sulphur 25 kg/ha thrice. The treatment increased seed yield by 173%.

Kotasthane and Agrawal (1978) most effectively control powdery mildew of mungbean with bavistin followed by benomyl. captan and dithane Z-78 were the less effective fungicide.

Quebral and Cowell (1978) reported spray of benomyl at 30 g/100 l twice at interval of 10-14 days to control powdery mildew of mungbean. The treatment increased yield from 903 to 1139 kg/ha.

Gurha and Gangal (1980) tested 6 fungicide and found best control of powdery mildew of green gram with sulphur (Thiovit) followed by carbendazim (Bavistin). However, carbendazim treatment gave highest yield compared to sulphur.

Zote *et al.* (1981) found markedly reduction in *Erysiphe polygoni* infection of *Vigna radiata* by foliar sprays of 0.5 kg/ha bavistin or karathane (dinocap) or 3 kg sulphur per ha compared to 5 grade infection in control effective treatment showed infection in traces. Bavistin, karathane and sulphur treatment gave 843, 796 and 870 kg yield per ha respectively compared to 173 kg in control.

Moghe *et al.* (1982) tested 8 fungicides against powdery mildew of greengram. Though all fungicides were effective, sulphur dust

and sulphen-80 gave complete elimination of disease and increased the yield by 172.59% and 141.56% respectively.

Agrawal and Philip (1983) achieved most economical control of *Erysiphe polygoni* on *Vigna mungo* with 3 sprays of 0.3% wettable sulphur at an interval of 12 day. The spray commenced immediately after the appearance of disease. Three sprays significantly increased number of pods per plant and the results were at par with two sprays.

Kotasthan and Gupta (1983) reported seed treatment with carbendazim (Bavistin) at 0.5 g/kg seed and 2 sprays of same fungicides @ 0.02%, 30 and 45 days after sowing was effective to control powdery mildew in mungbean, which generally appears during flowering and pod formation stage.

Nawaz and Narayansamy (1983<sup>c</sup>) obtained best control of *Erysiphe polygoni* infecting *Vigna mungo* and *Vigna radiata* with bavistin other effective fungicides were wettable sulphur, karathane, sulphex and benlate.

Singh and Singh (1983) found 3 sprays of ginger extract, garlic oil, dinocap, wettable sulphur or carbendazim at 20 days interval effective to control powdery mildew of pea incited by *Erysiphe polygoni*.

Sivaprakasam (1983) recorded best control of powdery mildew of black gram by benlate and sulphur. Sulphur dust and wettable sulphur increased the yield by 47.3 and 45.9% respectively and resulted in a net profit of Rs. 200 and 187 /ha.

Bharadwaj and Sharma ( 1984) observed baycor and calixin (tridemorph) highly effective to control powdery mildew of pea. However, calixin failed to give increased yield. bayleton (Tridemefan) gave highest yield increased, closely followed by bavistin, five sprays of 7 days interval were superior to 3 spray of 14 days interval.

Devi and Samy (1984) found inhibition of conidial germination of *Erysiphe polygoni* with karathane (dinocap), bavistin (carbendazim) and topsin-M (Thiophanate methyl). However, in the field, dinocap proved superior in reducing powdery mildew incidence in black gram.

Zote *et al.* (1985) tried 9 fungicides to control powdery mildew of mung (*Vigna radiata*) and obtained excellent control of the disease with sprays of bavistin (Carbendazim).

Krishnamohan *et al.* (1986) sprays of calixin (Tridemorph) or bavistin (Carbendazim) @ 0.1% has been reported effective to control powdery mildew of black gram and to increase the yield markedly.

Mehta and Suhag (1986) tested 4 fungicides against powdery mildew of mungbean and all were found to give significant reduction of the disease. Calixin (tridemorph) sprays resulted in highest yield but sprays of wettable sulphur gave best cost benefit ratio.

Raut *et al.* (1986) found effective of calixin (tridemorph) over their fungicides against powdery mildew of green gram and black gram, calixin gave highest disease control of 67.89 and 58.03% and highest grain yield of 162.70 and 103.69% over control in green gram and black gram, respectively.

Tiwari and Kotasthane (1986) recorded least incidence of powdery mildew and obtained highest yield of mungbean with 2 sprays of bavistin (Carbendazim at 0.05%).

Elazegui and Mew (1987) while working out cost benefit ratio to control powdery mildew of *Vigna radiata* with fungicides, observed that sprays of thiophanate methyl (Topsin) were more economical than benomyl.

Khosla *et al.* (1988) found effective control of powdery mildew (*Erysiphe polygoni*) of *Vigna radiata* and *Vigna mungo* with bavistin (carbendazim), bayleton (tridemefon), calixin (tridemorph), karathane (dinocap) and microsulf. All tested fungicides gave significant increase in yield.

Rabindran *et al.* (1988) sprayed different fungicides at various stages of infection to control powdery mildew of black gram and found carbendazim (0.1%) most effective when applied at first appearance of the disease and again after 15 days.

Begum (1989) found reduced incidence of *Erysiphe cichoracearum* in field pea with all the 7 fungicides under test. Lowest incidence was obtained with Tilt (propiconazole) followed by calixin (tridemorph), thiovit (Sulphur) and karathane (dinocap).

Bhatia and Thakur (1989) evaluated systemic and non-systemic fungicides against powdery mildew of mungbean and recorded maximum disease reduction by spraying bavistin (73.5%) followed by sulfex-80 (66.0%). Bavistin was effective but not as economical as sulfex-80. Cost benefit ratio with bavistin was 1:0.24 compared to 1:2.40 with sulfex-80.

Das and Narain (1990) obtained significant control of powdery mildew of *Vigna radiata* by spraying bavistin (carbendazim), topsin-M (thiophanate methyl), karathane (dinocap), Derosal (carbendazim) and sulfex (wetable sulphur). However, a single spray of 0.4% sulfex gave highest cost benefit ratio of 3.3.

Kunkaliker and Padaganur(1990) recorded 87.7% reduction in powdery mildew incidence of *Vigna radiata* by spraying 0.2% tridemorph (Calixin), it was also a economical treatment compared to carbendazim, zirum and copper oxychloride. However, maximum grain yield was recorded in carbendazim treatment.

Abbaiah and Devi (1992) most effectively controlled *Erysiphe polygoni* on black gram by spraying 0.1% carbendazim and obtained maximum net return. However, cost benefit ratio was highest (1:6.7) in thiophanate methyl (Topsin-M) treatment.

Panja and Chaudhari (1994) tested 3 systemic fungicides viz., Fenarimol (Rubigan 12 EC), carbendazim (Bengard 50 WP) and tridemorph (Calixin 75 EC) and 3 non systemic viz., dinocap (Karathane 48 EC), elemental sulphur (sulfex 80 WP) and mancozeb (Dithane M-45) against powdery mildew of pea and reported fenarimol most effective and economic.

✓ Bhakre (1995) observed tridemorph was found suitable to control the disease and maximum yield also obtained followed by wettable sulphur and dinocap.

Setty *et al.* (1996) assessed effectively of carbendazim, tridemorph (Calixin), dinocap, sulphur, tridemefon (Bayleton) and mancozeb + dinocap against powdery mildew of black gram and obtained best results with carbendazim.

✓ Srivastava (1996) determined the ability of bavistin (Carbendazim) 0.1%, topsin-M (thiophanate methyl) 0.1%, calixin (triofanate) 0.05%, captaf (captan) 0.2%, cumarl (zirum) 0.2% wettable sulphur 0.3%, dithane M-45 (mancozeb) 0.2% and Kawach (Chlorothalonil) 0.1% to control powdery mildew of black gram. All fungicides significantly controlled the disease and gave increased yield. Among fungicides, bavistin, topsin-M, wettable sulphur and kawach proved superior in reducing disease intensity and increasing yield.

Saxena and Saxena (1999) found carbendazim @ 0.05 and 0.1% equally effective for the control of powdery mildew of green gram. The results of penconazole (Topas), carbendazim + copper oxychloride, chlorothalonil and tridemorph treatments were similar to that of carbendazim (0.05 and 0.1%). However, carbendazim at 0.05% gave maximum net profit followed by carbendazim 0.1%.

Sindhan *et al.* (1999) compared efficacy of extracts at 10 plant species with neemadol (Neem product) at 0.25%, 0.50% and 1.0% and karathane (dinocap) at 0.1% for the control of powdery mildew of pea. The results showed that most of the plant extracts @ 30% significantly reduced the disease compared to control. Neemadol and extract of *Azadirachta indica*, *Allium cepa*, *A. sativum* and *Zingiber officinale* were highly effective and at par with dinocap in reducing disease intensity also *Eucalyptus globulus* and *Datura alba* inhibit the growth of powdery mildew. The efficacy of extracts increased with increasing concentration.

Singh *et al.* (1999) found rhizome powder of medicinal plants *Zingiber officinale* and *Acorus calamus* highly effective against *Eryiphe pisi*

*in vitro*. Foliar sprays of 50% (w/w) formulated product of *Acorus calamus* and *Z. officinale* reduced disease intensity of powdery mildew under field conditions from 80% to 9.2% and 45.3% respectively. The results of these products were quite comparable with commonly used fungicide wettable sulphur and carbendazim.

Naik (2000) reported that the highest and lowest per cent disease intensity (90.22% and 92.80% and 8.12% and 9.62%) was recorded in control and calixin sprayed plot during 1996 and 1997 respectively. Significantly highest grain yield (1400 kg/ha and 1442 kg/ha) was obtained in Calixin (0.05%) sprayed plot as compared to the sprayed control plot (746 kg/ha and 792 kg/ha) during 1996 and 1997 respectively.

Zote *et al.* (2000) found bavistin, kawach, karathane, bayleton, calixin and sulphur significantly reduces the powdery mildew of mungbean and increased the yield over unsprayed control. Bavistin 0.1% was most effective in reducing disease. Karathane 0.05% was the best in increasing grain yield significantly and also gave maximum net profit of Rs. 2937/ha.

Baravkar (2001) found that maximum control of powdery mildew of green gram by bel (*Jagle marmalous*) leaves extract (5%). Among the other plant extract neem (*Azardirecta indica*) leaves extract, beshram (*Ipomoea cornea*) leaves extract, nilgiri (*Eucalyptus globulus*) leaves extract, sadaphuli (*Vinca rosea*) leaves extract were also effective to control the disease over check.

Gupta (2001) reported that maximum spore inhibition of *Erysiphe polygoni* (84.11%) was exhibited by garlic bulb extract, followed by tapioca leaf extract (77.64%) in green gram.

Tripathi *et al.* (2001) conduct a field experiment to manage powdery mildew (*Erysiphe polygoni* DC) of pea (*Pisum sativum* L.) by fungicides, plant extracts and host resistance. Results indicated that two sprays of tridemorph and dinocap @ 0.1 per cent highly effective (than carbendazim, wettable sulphur, fenarimol, penconazole, chlorothalonil difenconazole) in reducing the disease and increasing yield when applied at the initiation and repeated at 10 days interval. Behada (*Terminalia*

and eucalyptus plant extracts. Similarly, *in vitro* maximum inhibition of spore germination was observed in tridemorph among the fungicides and behada among plant extracts.

Khunti *et al.* (2002) tested 10 fungicides against powdery mildew of green gram and reported that the lowest disease intensity (16.1%) and highest seed yield (77.9 kg/ha) with the application of hexaconazole (0.05%), tridemorph ranked next best in order to efficacy with (19.9%) disease intensity, however all tested fungicides significantly control disease over check (unsprayed).

Kunkulikar and Padaganur (2002) proved *in vitro* evaluation of fungicides tridemorph (at 0.01, 0.02 and 0.025%), carbendazim (at 0.03, 0.05 and 0.10%), mancozeb (at 0.10, 0.15 and 0.2%), copper oxychloride (at 0.10, 0.20 and 0.30%), wettable sulphur (at 0.05, 0.10 and 0.20%), zirum (at 0.10, 0.15 and 0.20%) against powdery mildew of green gram and found tridemorph was the most effective followed by carbendazim.

Saxena and Moly Saxena (2002) observed that spray of other fungicides like carbendazim with copper oxychloride in 1:1 ratio, tridemorph (0.075%) and penconazole (0.05%) was equally effective against powdery mildew of mungbean.

Dhakre (2003) reported that tridemorph (0.05%) recorded highest per cent disease control (72.68%) followed by carbendazim (68.57%) and wettable sulphur 0.3% (63.31%) chlorothalonil 0.05% (57.6%) and karathane 0.1%, (49.60%) whereas in plant extract neem leaves extract (5%) superior over eucalyptus leaf extract (5%) and behada leaves extract (5%) which control disease 33.05%, 32.41% and 21.17% respectively in powdery mildew of green gram.

Dod and Deshmukh (2003) in laboratory test against *Erysiphe polygoni* DC with eight fungicides dinocap (0.1%) tridemorph (0.05%) and thiophenate methyl (0.2%) gave highest per cent inhibition of spore germination followed by penconazole and carbendazim.

Patil *et al.* (2004) found two spray of propiconazole @ 0.1 per cent or carbendazim @ 0.1 per cent fenarimol @ 0.1 per cent or dinocap @

0.05 per cent and wettable sulphur @ 0.25% at 15 days interval from the disease appearance controlled the disease significantly with the added benefit of increase in grain yield. Carbendazim @ 0.1 per cent followed by wettable sulphur @ 0.25 per cent penconazole @ 0.05% and propiconazole @ 0.1 per cent provide effectiveness in respect of cost benefit ratio in controlling powdery mildew (*Erysiphe polygoni* DC) and (*Leveillulla taurica* Clev) of fenugreek.

Prasad and Dwivedi (2007) conducted field experiment to determine the effect of fungicides on field pea powdery mildew severity. Fungicides bavistin (WP), karathane, calixin, beyleton, hexaconazole and tilt were evaluated for the control of powdery mildew in pea (*Pisum sativum*). All the fungicide controlled the disease but tilt (Propiconazole was most effective treatment which not only increased seed yield but also reduced disease severity significantly as compared to unsprayed check followed by karathane (0.1%) and bavistin (0.1%).

Gupta and Kumar (2008) various fungicides were evaluated for the control of powdery mildew (*Erysiphe pisi* DC) of pea. In which carbendazim caused complete conidial germination inhibition followed by wettable sulphur and kresoxim methyl while hexaconazole was least effective under *in vitro* conditions in protective spray programme, three sprays of kresoxim methyl (0.1%) at fortnightly intervals were found highly effective followed by difenconazole, penconazole, diniconazole and hexaconazole while wettable sulphur was least effective.

## CHAPTER III

### MATERIAL AND METHODS

The experiment on "Management of powdery mildew of green gram" was conducted during *kharif* 2008-09 at the Farm of University Department of Plant Pathology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The details of the materials used and methods followed are described in this chapter.

#### 3.1 Materials

##### 3.1.1 Green gram seeds

Seeds of green gram variety Kopergaon was obtained from Department of Plant Pathology and Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

##### 3.1.2 Inoculants and culture

The carrier based inoculants of *Rhizobium leguminosorum* was obtained from Biofertilizer Production Unit, Department of Plant Pathology, Dr. PDKV, Akola.

##### 3.1.3 Fertilizer

The recommended dose of chemical fertilizers viz., Nitrogen and Phosphorus 20:40 kg/ha was applied through urea and single super phosphate as a basal dose as per the treatment details.

##### 3.1.4 Glasswares

The glasswares used in this experiment were petriplates, conical flasks, measuring cylinder, cavity slides, slides, dessicators, glass rods etc.

##### 3.1.5 Equipments

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

##### 3.1.6 Chemicals

The chemicals used during the studies were chemically pure (CP) grade.

1. Tridemorph (Calixin)
2. Dinocap (Karathane)
3. Propiconazole (Tilt)
4. Penconazole (Topas)
5. Diphenconazole (Score)
6. Hexaconazole (Contaf)
7. Wettable sulphur (Sulfil)
8. Benlate (Benomyl)

For accuracy chemical were weighed on chemical balance. Chemical required in minute quantities were weighed on electrical monopan balance during analysis freshly prepared chemicals were used along with standard normality of chemical solution.

### **3.1.7 Plant leaf extract and bioagent**

1. Tapioca (*Manihot utilissimum*)
2. Behada (*Terminali beherica*)
3. Eucalyptus (*Eucalyptus globus*)
4. Sadafuli (*Vinca rosea*)
5. Parthenium (*Parthenium hysterophorus*)
6. *Pseudomonas fluorescens* culture filtrate.

### **3.1.8 Miscellaneous material**

Distilled water, rectified spirit, polythene bags, rubber bands, cotton plugs (Swab), tags and labels, marker, brown paper bags, were used during the experimentation.

## **3.2 Methods**

### **3.2.1 Seasonal incidence**

Seasonal incidence of disease were recorded on two plots of 10 x 10 m one control and one protected by prophylactic sprays of recommended fungicides. Weekly observation on disease intensity were recorded after initiation of disease. The disease occurrence was correlated with weather parameter viz., temperature and humidity.

### 3.2.2 Influence of sowing date

Influence of sowing dates the crop were sown at onset of rain i.e. 1<sup>st</sup> July followed by three successive dates at weekly interval as follows and the layout of experiments are given in Fig. 1 and Plate 1.

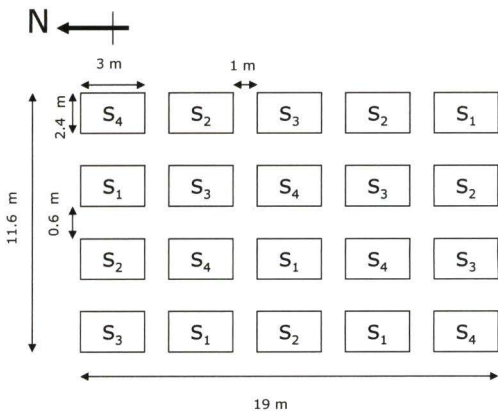
#### Details of field experiment

1. Duration of experiment : *Kharif* 2008
2. Design : Randomized Block Design (RBD)
3. Treatment : Four (4)
4. Replications : Five (5)
5. Plot size : Gross – 2.40 x 3.00 m<sup>2</sup>  
Net - 1.80 x 2.40 m<sup>2</sup>
6. Spacing : 30 x 10 cm<sup>2</sup>
7. Variety : Kopergaon
8. Date of sowing : S<sub>1</sub> – 1<sup>st</sup> July 2008  
S<sub>2</sub> – 8<sup>th</sup> July 2008  
S<sub>3</sub> – 15<sup>th</sup> July 2008  
S<sub>4</sub> – 22<sup>nd</sup> July 2008
9. Date of harvesting : S<sub>1</sub> – 7<sup>th</sup> September 2008  
S<sub>2</sub> – 14<sup>th</sup> September 2008  
S<sub>3</sub> – 21<sup>st</sup> September 2008  
S<sub>4</sub> – 28<sup>th</sup> September 2008

### 3.2.3 Effect of temperature on the germination of powdery mildew conidia

BOD incubator was used for this experiment conidia of powdery mildew from young infected leaf were mixed in sterile distilled water and one drop of the spore suspension was put into cavity slide with three replications. The cavity slides were incubated in BOD incubator at desired temperature viz., 10<sup>0</sup>C, 15<sup>0</sup>C, 20<sup>0</sup>C, 25<sup>0</sup>C, 30<sup>0</sup>C and 35<sup>0</sup>C for 24 hr respectively. Germination count of conidia was recorded at each temperature level.

### 3.2.4 Effect of relative humidity on germination of powdery mildew conidia



**Fig. 1. Plan of layout of different dates of sowing in green gram**



Plate 1 : View of exerpermental plot

To study the effect of different levels of relative humidity, the experiment was conducted in laboratory to assess the germination of conidia of powdery mildew. The concentrated sulphuric acid was used in different concentration with calibrated amount of distilled water for maintaining different RH levels. Solomon (1951) used proportionate amount of sulphuric acid and distilled water was used for desired relative humidity as follows.

RH % at 25 <sup>0</sup> C	Wt % (g H <sub>2</sub> SO <sub>4</sub> per 100 g solution)
90	17.91
80	26.79
70	33.09
60	38.35
50	43.10
40	47.71
30	52.45

Conidial germination were tested at 30%, 40, 50, 60, 70, 80 and 90 per cent humidity for 24 hrs respectively. On the cavity slides a drop of spore suspension was taken, into which conidia of powdery mildew from fresh young sample were inoculated by brush. Seven desiccator were used. In each desiccator calibrated amount of distilled water and sulphuric acid was taken. The cavity slides inoculated with powdery mildew conidia, were placed in desiccator. The mouth of desiccator was sealed with greese immediately after inserting the slide in it. The desired relative humidity was allowed to create inside the desiccator. The germination of conidia was counted after 24 hrs at each level of relative humidity. The experiment was conducted at room temperature and replicated three times.

### **3.2.5 Effect of light and darkness on germination of powdery mildew conidia**

Powdery mildew conidia were obtained from young infected leaves and inoculated in the sterile distilled water and one drop of spore suspension was taken on the cavity slides. The cavity slide were incubated under 24 hr light, 24 hr darkness and 12 hr light-12 hr darkness at room temperature.

24 hrs darkness was maintained by using black carbon paper. Cavity slides were kept in Petridish the Petridishes were covered by a black carbon paper so that light could not pass inside the Petridish thus the darkness was obtained for the germination of conidia. Petridishes were incubated for 24 hrs.

24 hrs light was maintained by use of tube light. Cavity slides were kept in Petridish the Petridish were kept under light for 24 hrs.

12 hr light and 12 hr darkness was maintained by use of carbon paper and light. Cavity slides were kept in Petridish. The Petridish covered by a carbon paper for about 12 hr and then remove carbon paper and kept this Petridish under light for 12 hr.

The germination count of conidia was recorded after 24 hrs.

### **3.2.6 Management of powdery mildew of mungbean**

#### **3.2.6.1 Efficacy of chemical fungicides, plant extracts and bioagent *in vitro***

*In vitro* evaluation of chemicals, botanicals and bioagents were made by inhibition of spore germination techniques by hanging drop method.

#### **Hanging drop method**

##### **a. Preparation of spore suspension**

Fresh green gram leaves infected with powdery mildew were collected from unsprayed plants. Superficial fungal growth was scrapped with brush and incorporated in sterile distilled water.

##### **b. Preparation of chemical bioagent, botanicals concentration**

The double strength solutions of chemical, botanicals or bioagent were made in sterile distilled water.

##### **c. Preparation of moist chamber**

The Petriplates of 10 cm diameter were used for preparation of moist chamber. Then 2 moist blotter paper were kept at the bottom and 1 moist blotter paper kept in the top of Petriplate. Two glass rods were kept at the bottom on the moist blotter paper in Petriplate. One drop spore suspension mixed with 1 drop of double strength solution of chemical,

botanicals or bioagent. A loopful above suspension was taken on clean coverslip and later inverted on cavity slides. These slides were placed on the glass rod and incubated for 24 hr at room temperature.

#### d. Recording observations

At the end of incubation period slides were removed from petriplates and observed under light microscope. Total number of oidia per microscopic field and number of oidia germinated were recorded and per cent inhibition was calculated by following formula.

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

PI - Per cent inhibition of germination

C - Per cent of oidia germinated in control

T - Per cent of oidia germinated in treatment

#### Preparation of plant extracts

The standard aqueous extracts of plant material were obtained by grinding the appropriate washed plant leaf in mortar and pestle in presence of equal amount of sterile distilled water (w/v). The leaf extracts so prepared were filtered using two folds of muslin cloth (Chowdhary and Saha, 1985). These leaf extracts were tested against powdery mildew fungus in laboratory as well as in field.

Two sprays were taken at an interval of 7 days.

**Table 1. Chemical fungicide, botanicals and bioagent used *in vitro* concentration**

Sr. No.	Chemicals	Concentration (%)
1	Tridemorph	0.05
2	Dinocap	0.1
3	Penconazole	0.05
4	Propiconazole	0.05
5	Diphenconazole	0.1
6	Hexaconazole	0.1
7	Wettable sulphur	0.30
8	Benomyl	0.2
	<b>Botanicals</b>	
9	Tapioca extract	5
10	Behada extract	5
11	Eucalyptus extract	5
12	Parthenium extract	5
13	Sadaphuli extract	5
	<b>Bioagents</b>	
14	<i>Pseudomonas fluorescens</i>	5
15	Control	

### 3.2.6.2 Efficacy of chemical, botanicals and bioagent against *Erysiphe polygoni* in vivo

#### a. Layout

The experiment was laid out in a Randomized Block Design (RBD) with three replications and 15 treatments as given below and the layout of experiment is presented in Fig.2.

#### Details of field experiment

Design : Randomized Block Design (RBD)

Treatment : 15 (Fifteen)

Replication : 3 (Three)

Size of plot : Gross – 2.40 x 3 m<sup>2</sup>  
Net – 1.80 x 2.40 m<sup>2</sup>

Spacing : 30 x 10 cm<sup>2</sup>

Variety : Kopergaon

Date of sowing : 1<sup>st</sup> July, 2008

Incidence of powdery mildew noticed on : 5<sup>th</sup> Aug., 2008

Date of spraying : 16.08.2008

23.08.2008

Date of observation : 15.08.2008

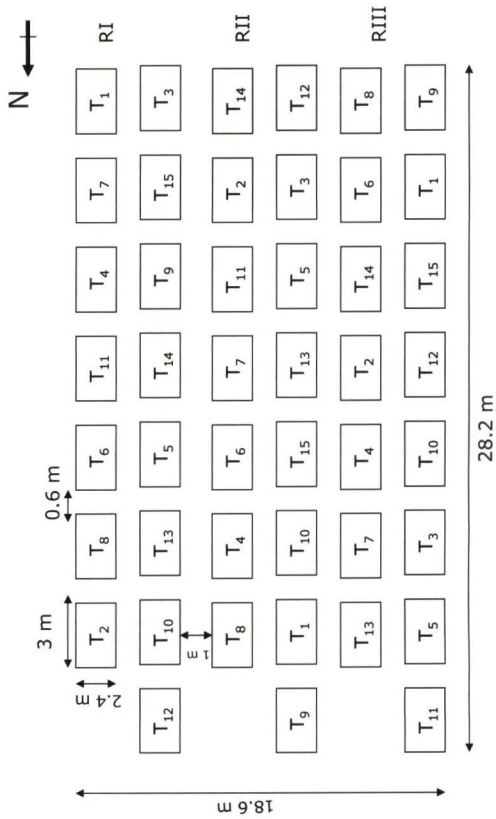
22.08.2008

29.08.2008

Date of harvesting : 07.09.2008

**Table 2. Details of treatments tested in vivo**

Sr. No.	Chemicals	Concentration (%)
T <sub>1</sub>	Tridemorph	0.05
T <sub>2</sub>	Dinocap	0.1
T <sub>3</sub>	Propiconazole	0.05
T <sub>4</sub>	Penconazole	0.05
T <sub>5</sub>	Diphenconazole	0.1
T <sub>6</sub>	Hexaconazole	0.1
T <sub>7</sub>	Wettable sulphur	0.3
T <sub>8</sub>	Benomyl	0.2
T <sub>9</sub>	Tapioca leaf extract	5
T <sub>10</sub>	Behada leaf extract	5
T <sub>11</sub>	Eucalyptus leaf extract	5
T <sub>12</sub>	Sadaphuli leaf extract	5
T <sub>13</sub>	Parthenium leaf extract	5
T <sub>14</sub>	<i>Pseudomonas fluorescens</i> (culture filtrate)	5
T <sub>15</sub>	Control	-



**Fig. 2. Plan of layout for green gram powdery mildew control**

The experimental crop of green gram was provided with normal recommended doses of fertilizer. The plant protection measures were undertaken as and when required as per plant protection schedule to prevent the damages from sucking insect pest irrigation and interculture operations were given as and when required.

**b. Preparation of fungicidal suspension and plant extract and bioagent for spraying**

Each fungicidal suspension was prepared in water in plastic container (Bucket) according to concentration as it has been given in treatment details. The plant extracts was prepared in known quantity of distilled water and strained through muslin cloth and the bioagent i.e. *Pseudomonas fluorescens* culture filtrate was taken according to concentration as it has been given in treatment details. Two sprays were given after initiation of disease by using knapsack sprayer.

Date of spraying are given below.

Number of spray	Date of spraying
1	16.08.2008
2	23.08.2008

The recommended cultural practices were followed.

One spraying of dimethoate (Roger) 1 ml/lit of water concentration were given in all the plots as a general cover spray for insect controls on 14.08.2008 and also protective irrigation was provided due to drought condition first on 15.07.2008 and on 27.07.2008.

**c. Recording of field observation**

Plant disease intensity was recorded on randomly selected 10 plants in the field. Six leaf (Two from top, two from bottom and two from middle) from each plant were selected and on the basis of relative per cent leaf area covered by the disease. Scoring of six leaves was done in 0 to 5 grade scale as follows.

### Disease rating scale for powdery mildew of green gram (AICRP)

Grade	Description	Reaction
0	Plants free from infestation	Highly resistant (H.R.)
1	Few plants showing traces to 10% infection on leaves, stems free from infection	Resistant (R)
2	Slightly infection with fine coating of powdery growth on leaves covering 10.1 to 25% leaf area, slight infection on stems, pods usually free	Moderately resistant (M.R.)
3	Dense powdery coating covering 25.1 to 50% leaf area moderate infection stems, slight infection on pods	Moderately susceptible (M.S.)
4	Dense powdery coating covering 50.1 to 75% leaf area, stem heavily and pods moderately infected, infected portion turn grayish	Susceptible (S)
5	Severe infection with dense powdery growth covering more than 75% area of the whole plant including pods, plants resulting in premature defoliation and drying	Highly susceptible (H.S.)

The per cent disease index was calculated by following formula.

$$\text{PDI} = \frac{\text{Summation of grades}}{\text{No. of plant Observed} \times \text{No. of leaves observed} \times \text{Highest grade}} \times 100$$

#### 3.2.7 Host varietal resistance against powdery mildew

Green gram genotype were screened against powdery mildew disease under field condition in Pulses Research Unit, Dr. PDKV, Akola and periodical observation were recorded in 0-5 scale (AICRP) on disease intensity and also weekly weather data collected from Meteorological Observatory Department of Agronomy, Dr. PDKV, Akola.

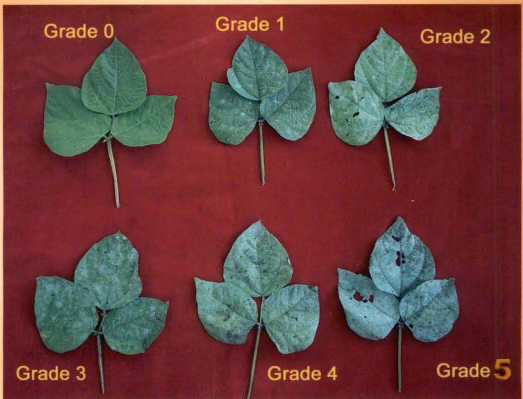


Plate 2 : 0 to 5 Grade infection of *Erysiphe polygoni* on green gram leaves

## CHAPTER IV

### RESULTS AND DISCUSSION

Green gram (*Vigna radiata* (L.) Wilczek) is considered as the most important pulse crop grown throughout India. Powdery mildew caused by *Erysiphe polygoni* DC is a serious disease and a major constraint with regard to production. However, its importance has been realized in the recent year due to increase in prices of green gram. The disease is becoming increasingly important as it reduce the yield to the extent of 100%. Therefore, the present studies were undertaken to find out the influence of weather parameters on the development of powdery mildew disease which can be useful for forecasting the disease, management of disease through fungicides, plant extracts, culture filtrate of bioagent and screening of different varieties for their disease reaction. The results of the present investigation are discussed here as under.

#### 4.1 Symptoms of powdery mildew and morphology of fungus

The disease initiated with the formation of small diffused spots on upper surface of lower older leaves. Infected lesions showed white powdery mass of fungus and soon covered both surfaces of the leaf. In case of severe infection, powdery growth was evident on stem and inflorescence. Inflorescence infection adversely affected pod setting. Affected tissue turned dirty white to brown with advanced age. Premature leaf fall due to severe infection of the fungus was commonly noticed in green gram. Powdery coating on the infected parts of green gram contained mycelium and conidial mass of the fungus. The disease appeared in severe form after flowering.

The disease causing fungus *Erysiphe polygoni* DC is ascomycetous fungus, obligate ectoparasite. The fungus spread on the surface and absorb nutrient from infected tissue of green gram by sending haustoria into epidermal cells. The fungus produce amphigenous, dirty white mycelium, septate conidiophores arised vertically from superficial hyphae and borne barrel shaped conidia either singly or in chains. Its

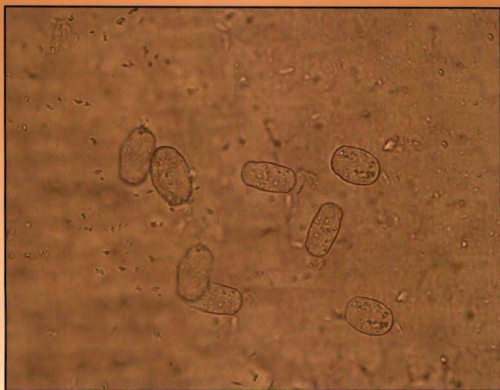


Plate 3 : Conidia of *Erysiphe polygoni* on green gram



Plate 4 : Conidial germination of *Erysiphe polygoni*

sexual stage (cleistothecia) was not observed in green gram, during course of studies.

The symptoms and morphology recorded in the present study almost matched with those reported on pulses by various earlier workers. Yarwood (1957), Sankhla *et al.* (1967), Hans and Boesewinkel (1980), Raut *et al.*, (1986), Raghuchander *et al.* (1998), Mandhare *et al.* (2008), Raghuchander *et al.* (1998) observed severe incidence of powdery mildew on black gram at vegetative stage compared to maturity. On the contrary in the present studies powdery mildew was severe after flowering upto crop maturity as evidenced earlier by Raut *et al.* (1986).

#### 4.2 *In vitro* studies of powdery mildew of green gram

Different levels of temperature, relative humidity, light and darkness were tested against powdery mildew conidia in laboratory and the result are as under.

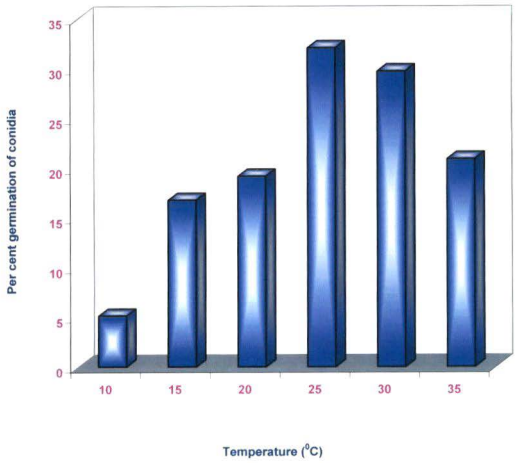
##### 4.2.1 Effect of different levels of temperature on germination of conidia of powdery mildew *in vitro*

Temperature influence the disease development under natural condition. In order to know the optimum temperature requirement of powdery mildew pathogen, the conidia of *Erysiphe polygoni* were exposed to different temperature under control condition and the data obtained is presented in Table 1 and graphically illustrated in Fig. 3.

**Table 1. Effect of different levels of temperature on conidial germination of *Erysiphe polygoni in vitro***

Levels of temperature (°C)	Average per cent germination of conidia after 24 hours
10	5.14 (13.08)
15	16.77 (24.16)
20	19.18 (25.97)
25	32.04 (34.46)
30	29.69 (33.02)
35	20.90 (27.13)
'F' test	Sig.
SE(m)+	0.71
CD P = 0.01	2.75

\* Figures in parenthesis arc sin value



**Fig.3. Conidial germination with respect to temperature**

Data from the table indicated that there was minimum germination of conidia at 10<sup>0</sup>C. Whereas highest germination of conidia was observed at 25<sup>0</sup>C temperature and gave 32.04% conidial germination. The conidial germination at 30 and 35<sup>0</sup>C is numerically less than that of 25<sup>0</sup>C but it was statistically on par with germination observed at 25<sup>0</sup>C. This clearly indicates that regime of 25 to 30<sup>0</sup>C temperature favoured the conidial germination.

Similar results were reported by Paulech ( 1969) obtained optimum temperature for germination of conidia *E. polygoni* at 25<sup>0</sup>C temperature, Saharan and Sheoran (1988) obtained maximum germination of conidia *Erysiphe cruciferum* at range of 21±1<sup>0</sup>C temperature. Badgujar (1995) also found maximum germination of conidia *E. polygoni* at range of 25 to 30<sup>0</sup>C temperature.

#### 4.2.2 Effect of different levels of relative humidity on germination of conidia of powdery mildew of green gram *in vitro*

Relative humidity played an important role in disease development under natural field condition. In order to know the optimum relative humidity requirement the conidia of *Erysiphe polygoni* DC were exposed to different levels of relative humidity in desicator (Plate 5) and data obtained is presented in Table 2 and graphically illustrated in Fig.4.

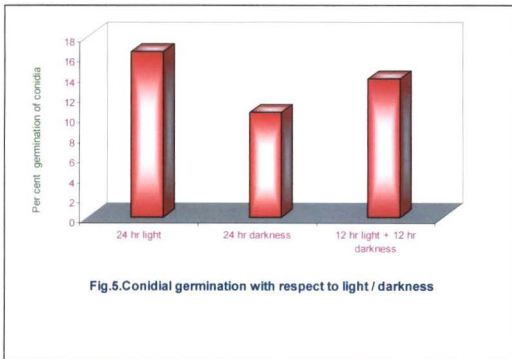
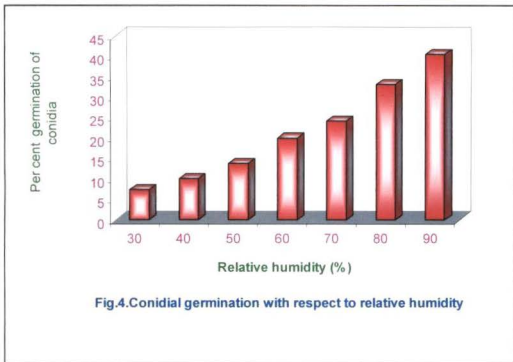
**Table 2. Effect of different levels of relative humidity on conidial germination of *Erysiphe polygoni in vitro***

Levels of relative humidity (%)	Average per cent germination of conidia after 24 hrs
30	7.30 (15.62)
40	9.93 (18.36)
50	13.73 (21.71)
60	19.93 (24.29)
70	24.19 (29.43)
80	33.15 (35.15)
90	40.52 (39.52)
'F' test	Sig.
SE(m)+	0.66
CD P = 0.01	2.58

\* Figures in parenthesis arc sin value



Plate 5 : Experiment of effect of humidity on conidial germination *in vitro*



It is revealed that germination of conidia of powdery mildew of green gram increased with increased in the levels of relative humidity and maximum germination i.e. 40.52% was observed at 90% RH which was significantly superior among various humidity levels. The least germination of conidia was observed at 30% relative humidity i.e. 7.30%. Similar results were reported by Paul and Kaushal (1985) and stated that optimum germination of conidia was in the regime of 70-100% RH. The germination is seem to be affected by rising RH was observed in present investigation and same results were obtained by Schnathrost (1959), Badgujar (1996) observed maximum germination of conidia at 95% RH, Mandhare and Suryawanshi (2007) observed maximum conidial germination 56.50% was recorded at 90% relative humidity at 42 hrs.

#### 4.2.3 Effect of light and darkness on the germination of conidia of powdery mildew *in vitro*

Germination of conidia were tested at 3 three different light exposure. Exposure to light for 24 hours, exposure to darkness for 24 hours and alternate light and darkness for 12-12 hours and the result are presented in Table 3 and graphically illustrated in Fig. 5.

**Table 3. Effect of light/darkness on conidial germination of *Erysiphe polygoni in vitro***

Condition	Average per cent germination of conidia after 24 hrs
24 hr light	16.38 (4.03)
24 hr darkness	10.40 (3.22)
12 hr light + 12 hr darkness	13.72 (3.69)
'F' test	Sig.
SE(m) $\pm$	0.18
CD P = 0.01	0.68

\* Figures in parenthesis are square root value

**Table 4. Effect of environmental factors on disease development**

Met. Week	PDI	Temperature (°C)		Sunshine hrs	Wind velocity (kmph)	Relative humidity (%)		Rainfall (mm)
		Max.	Min.			Morn.	Even.	
31	9.3	29.7	24.0	2.0	10.1	90	74	27.6
32	14.66	27.8	23.5	0.3	11.8	90	79	62.6
33	17.33	31.1	23.9	3.9	8.0	85	60	3.30
34	25.33	32.5	24.0	5.9	7.4	81	58	13.60
35	34.66	31.9	23.6	4.3	2.1	91	56	11.90
36	38.00	31.8	23.2	5.0	1.8	94	63	61.40
37	41.33	30.6	22.7	5.0	4.1	94	70	87.70
38	42.66	29.7	22.6	4.0	5.3	91	71	25.10

**Relative humidity**

Relative humidity played an important role in disease development. Morning RH 85 to 94% favoured the conidial germination whereas evening RH 56 to 70% favoured the fast sporulation of the pathogen.

**Temperature**

Temperature also played an important role in the disease development. Optimum temperature range of 27.8 to 32.5°C was found to be favourable for the development of maximum disease. However minimum temperature was more or less constant from 31<sup>st</sup> to 38<sup>th</sup> met. week in the range of 22.6 to 24°C and possibly not exhibited any role in disease development. *In vitro* studies indicated significant germination of conidia in between the range of 25 to 30°C temperature.

**Sunshine hours**

Total sunshine hours per day were less from 31<sup>st</sup> to 33<sup>rd</sup> MW. In 34<sup>th</sup> MW total sunshine hours per day increased and it was 5.9 hrs however from 35<sup>th</sup> to 38<sup>th</sup> MW it remains more or less constant in the range of 4.3 to 5.0 hrs and higher disease intensity was also observed in those week and highest i.e. 42.66 during 38<sup>th</sup> MW.

**Wind velocity**

Maximum disease intensity was noticed in the field from 35<sup>th</sup> to 38<sup>th</sup> MW whereas the wind velocity was in the range of 4.1 to 5.3 km/hr.

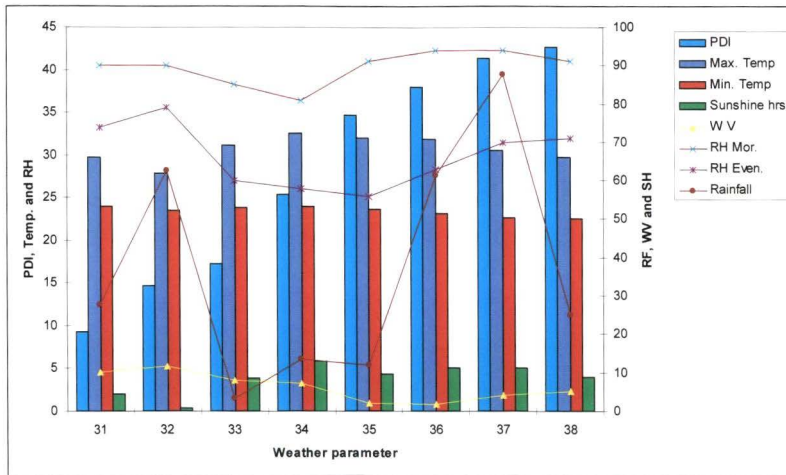


Fig. 6 : Effect of weather parameters on PDI of powdery mildew of green gram

Less wind velocity favoured the early settlement of spores within the field which helped in the manifestation of the disease. Powdery mildew was noticed less in 31<sup>st</sup> to 34<sup>th</sup> MW where wind velocity was more than 7 km /hr.

#### 4.3.2 Correlation coefficient of disease intensity of powdery mildew of green gram with various weather factors

The per cent disease intensity of powdery mildew of green gram var. Kopergaon is correlated with various weather parameters of current and preceding week and the result shown in Table 5.

**Table 5. Correlation coefficient of disease intensity of powdery mildew of green gram with various weather parameters of current week and preceding week**

	Max. temp.	Min. temp	Sunshine hours	Wind velocity	Morn. RH	Even. RH	Rainfall	'r' value at 5%
Current week	0.367	0.810*	0.652	0.852*	0.473	0.274	0.303	0.707
Preceding week	0.446	0.599	0.794*	0.800*	0.045	0.519	0.096	0.707

\* Significant at 5% level

It is revealed from Table 5 that, the meteorological parameters of current week and preceding week were correlated with the per cent disease intensity. It was observed that sunshine hours and wind velocity of preceding week have significant positive correlation with the disease development. This clearly indicates that sunshine hours, high wind velocity, played an important role in disease development. Role of weather parameters of current week when analyzed for its correlation with the disease, only minimum temperature and wind velocity was found positively correlated with the disease. Minimum temperature was more or less constant during development of the disease which was quite nearer to the optimum temperature required for disease development. Wind velocity influenced the spread of conidia to short or long distance. Wind velocity in all ranges helped in passive dispersal of the pathogen.

Similar observations were reported by Yarwood ( 1936), Yarwood *et al.* (1954), Yarwood (1957), Schnathrost (1959), Soria and Quebral (1973), Deshpande and Dake ( 1978), Agrawal and Philip (1983),

Paul and Kaushal (1985), Hseih *et al.* (1988), Kunkaliker and Padaganur (1989), Mittal and Sharma (1992), Raghuchander and Rajappan (1995), Thakur and Agrawal (1995), Saxena *et al.* (1997), Gupta (2001), Bhattacharya and Shukla (2002), Singh and Sirohi (2003), Mandhare and Suryawanshi (2007), Mandhare *et al.* (2008). The present results on the similar line of their reports.

#### 4.4 Effect of date of sowing on powdery mildew of green gram and yield

In green gram, powdery mildew appear on 5<sup>th</sup> August in all sowing dates (Table 6). Severity of disease increased subsequently and was maximum (peak) on 27 August. The disease intensity was significantly less in the crop sown at 1<sup>st</sup> July and 8<sup>th</sup> July.

Disease severity peak was on 27<sup>th</sup> August i.e. in 1<sup>st</sup> July sowing was 27.99% and in 8<sup>th</sup> July i.e. 27.46% which were significantly less than that of crop sown at 15<sup>th</sup> July and 22<sup>nd</sup> July showing 36.39% and 38.79% disease intensity. This clearly indicated that delayed sown crop succumbed the disease (Fig. 7 and Plate 6).

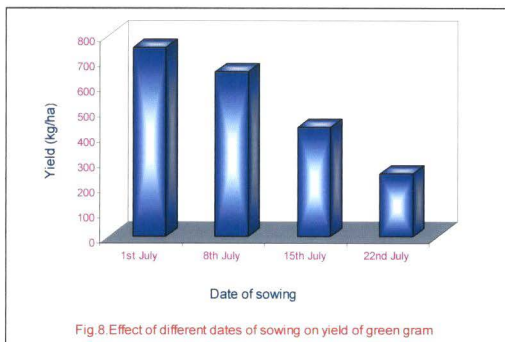
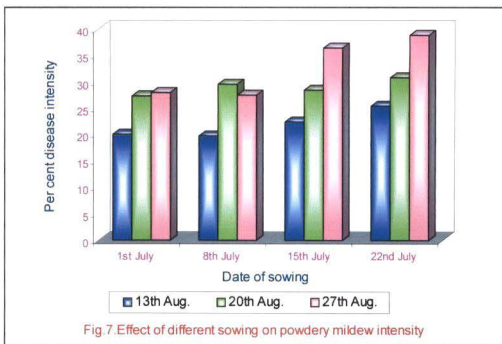
As regards the grain yield it was significantly higher in crop sown at 1<sup>st</sup> July than that of crop sown at 15<sup>th</sup> July and 22<sup>nd</sup> July. However, it was at par with the crop sown at 8<sup>th</sup> July (Fig.8). Higher grain yield (750 kg/ha) was recorded in the crop sown on 1<sup>st</sup> July followed by the crop sown at 8<sup>th</sup> July (652.77 kg/ha) and yield decreased by 66.48% by delayed sowing from 1<sup>st</sup> July to 22<sup>nd</sup> July.

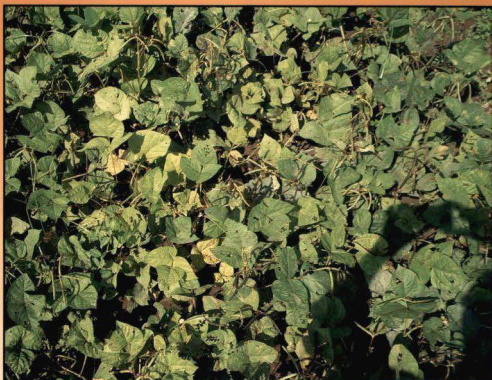
**Table 6. Effect of different dates of sowing on powdery mildew of green gram and yield**

Sowing dates	PDI recorded on			Yield (g/plot)	Yield (kg/ha)
	13 <sup>th</sup> Aug.	20 <sup>th</sup> Aug.	27 <sup>th</sup> Aug.		
1 <sup>st</sup> July	19.99 (4.47)*	27.33 (31.46)**	27.99 (29.30)**	540	750
8 <sup>th</sup> July	19.73 (4.44)	29.53 (32.86)	27.46 (31.58)	470	652.77
15 <sup>th</sup> July	22.39 (4.73)	28.39 (32.14)	36.39 (37.08)	311	431.94
22 <sup>nd</sup> July	25.37 (5.03)	30.79 (33.67)	38.79 (38.51)	181	251.38
'F' test	Sig.	NS	Sig.	Sig.	Sig.
SE(m)±	0.0586	0.83	0.41	48.88	67.88
CD P=0.05	0.180	-	1.26	150.59	209.15

\* Figures in parenthesis are square root value

\*\* Figures in parenthesis arc sin value





First date of sowing



Fourth date of sowing

Plate 6 : Effect of date of sowing on green gram powdery mildew

In all the sowing dates powdery mildew initiated on 5<sup>th</sup> of August 2008 i.e. 31<sup>st</sup> met. week. But the disease manifestation was different in different dates. Crop sown on 22<sup>nd</sup> July showed higher disease intensity (38.79%) in the peak period of the disease i.e. on 27<sup>th</sup> August whereas comparatively low disease severity was observed when the crop sown on 8<sup>th</sup> July (27.46%), 1<sup>st</sup> July (27.99%). The crop sown on 15<sup>th</sup> July also showed the higher disease intensity (36.49%). As regards the grain yield the crop sown at 1<sup>st</sup> July recorded highest grains i.e. 750 kg/ha which was significantly superior to the crop sown on 15<sup>th</sup> and 22<sup>nd</sup> July. The crop sown on 8<sup>th</sup> July also gave the good grain yield and it was on par with sowing date 1<sup>st</sup> July.

In the present study early sowing of green gram i.e. first week of July showed significantly higher yields than late July sowing. Similar observations were recorded by Kunkaliker and Padaganur (1991), Thakur (1992), Sivaprakasam *et al.* (1981), Singh and Sirohi (2003), Wadje *et al.* (2008). Thakur (1992) observed higher severity of green gram powdery mildew in 60 days old crop compared to 30 days. Similar observations were noted in the present studies in all sowing dates of green gram. Sivaprakasam *et al.* (1981) recorded higher incidence of *Erysiphe polygoni* in green gram and black gram in crops sown on 1 and 20 August compared to 10<sup>th</sup> September.

#### **4.4.1 Effect of date of sowing on different yield attributing characters**

To study the effect of disease severity of powdery mildew on yield attributing characters like number of pods/plant, weight of pods/5 plants and weight of grain/5 plant. A replicated trial at different dates of sowing under field conditions was conducted during *kharif* 2008 and results are given in Table 7 and graphically illustrated in Fig.9.

**Table 7. Effect of date of sowing on different yield attributing characters**

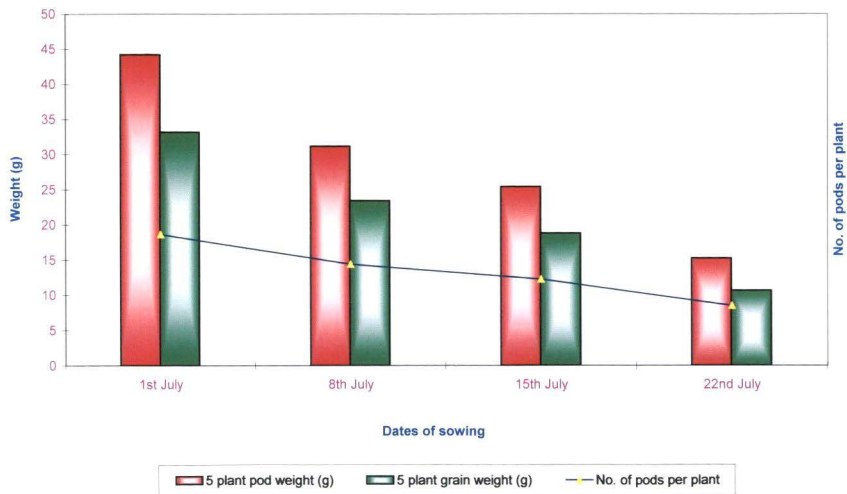
Date of sowing	No. of pods per plant	5 plant pod weight (g)	5 plant grain weight (g)
1 <sup>st</sup> July	18.64	44.22	33.18
8 <sup>th</sup> July	14.40	31.18	23.42
15 <sup>th</sup> July	12.28	25.42	18.83
22 <sup>nd</sup> July	8.52	15.26	10.68
'F' test	Sig.	Sig.	Sig.
SE(m) <sub>±</sub>	1.52	2.64	2.25
CD P = 0.05	4.68	8.15	6.95

It is revealed from Table 7 that there was significant differences in number of pods per plant, 5 plant pod weight, 5 plant grain weight due to dates of sowing, number of pods per plant (18.64) maximum pod weight (44.22 g) and grain weight (33.18 g) were observed in the first date of sowing (1<sup>st</sup> July) and it was significantly higher to 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> date of sowing. Whereas number of pods/plant, minimum pod weight/5 plant, grain weight/5 plant and i.e. 8.52, 15.26 g, 10.68 g respectively were found in fourth date of sowing (22<sup>nd</sup> July).

Present investigation corroborate the results of Dhakre (2003). Maximum number of pods per plant (5.11) was observed in the first date of sowing (30<sup>th</sup> June) in green gram. Wadje *et al.* (2008) observed the grain yield and test weight of green gram were significantly higher in crop sown on 7<sup>th</sup> July, thereafter both were decline significantly in subsequent delayed sown crop.

#### **4.5 Estimation of yield losses**

Yield losses caused due to powdery mildew of green gram were estimated in Kopergaon variety by adapting the disease rating scale (AICRP). The plant were classified in different groups and harvested separately. The yield obtained from each grade of disease intensity are presented below.



**Fig.9. Effect of dates of of sowing on different yield attributing characters**

**Table 8. Grain yield losses due to powdery mildew**

Variety	PDI	Yield (g/25 plant)	Yield losses (g)	Per cent yield losses
Kopergaon	0	175	0	0
	1-10	142	33	18.86
	10.1-25	130	45	25.71
	25.1-50	108	67	38.28
	50.1-75	99	76	43.43
	> 75	91	84	48.00

Table 8 indicated that maximum losses i.e. 48 per cent in grain yield were occurred when the powdery mildew intensity was more than 75 per cent. The losses were observed in the range of 18.86 to 48.00 per cent at varied intensity of the disease. Minimum losses were estimated at 1-10% intensity i.e. 18.66%.

From above data it is evident that the disease intensity has a direct influence on the reduction in grain yield. Observation of Singh *et al.* (1991) were in close agreement with the present investigation. They had reported the losses from 12.5 to 85.7% at varying disease intensity. Similar observations were reported by Uppal *et al.* (1935), Munjal *et al.* (1963), Quebral and Cowell (1978), Raut and Wangikar (1979), Nawaz and Narayansamy (1983), Thakur and Agrawal (1995), Ayub *et al.* (1996), Rathi and Tripathi (1994) Gupta (2001) and Tripathi *et al.* (2002).

#### **4.6 Effect of fungicides, plant extracts and culture filtrate of bioagent on inhibition of conidial germination of *Erysiphe polygoni* in vitro.**

Fungicidal suspension of tridemorph (calixin), karathane (dinocap), penconazole (topas), propiconazole (tilt), diphenconazole (score), hexaconazole (contaf), wettable sulphur (sulfil) and benomyl (benlate) and leaf extracts of tapioca (*Manihot utilissimum*), behada (*Terminalia bellerica*), eucalyptus (*Eucalyptus globulus*), sadafuli (*Vinca rosea*) and parthenium (*Parthenium hysterophorus*) and culture filtrate of *Pseudomonas fluorescens* along with untreated control were tested *in vitro* against conidia of *Erysiphe polygoni* by hanging drop method.

**Table 9. Effect of fungicides, plant extracts and culture filtrate of bioagent on conidial germination *in vitro***

Treatments	Concentration (%)	% germination of conidia	% inhibition over control
Tridemorph	0.05	5.14	85.11
Dinocap	0.1	8.26	76.07
Propiconazole	0.05	10.68	69.06
Penconazole	0.05	11.65	66.25
Diphenconazole	0.1	8.36	75.78
Hexaconazole	0.1	11.03	68.04
Wettable sulphur	0.3	7.28	78.91
Benomyl	0.2	9.60	72.19
Tapioca extract	5	12.31	64.33
Behada extract	5	11.58	66.45
Eucalyptus extract	5	16.30	52.78
Sadafuli extract	5	13.86	59.84
Parthenium extract	5	22.40	35.11
<i>Pseudomonas fluorescens</i>	5	12.45	63.93
Control	-	34.52	-
'F' test		Sig.	
SE(m) $\pm$		1.38	
CD P = 0.01		5.36	

Results of Table 9 indicated that, all the fungicides were found effective in inhibiting the spore germination. Minimum conidial germination was observed in the treatment tridemorph (0.05%) which was superior to all other treatment except wettable sulphur (0.3%), dinocap (0.1%), diphenconazole (0.1%) and benomyl (0.2%). These four treatments were found on par with the tridemorph (0.05%).

Among the plants extract behada 5% extract recorded 11.58% conidial germination which was significantly superior to control and parthenium 5% extract in inhibiting the conidial germination.

Culture filtrate of bioagent *Pseudomonas fluorescens* showed 12.45% conidial germination and it was on par with the plant extract but

superior to parthenium extract and control. Highest conidial germination 34.52% was observed in control.

Tridemorph gave maximum 85.11% inhibition of spore germination which was followed by wettable sulphur 78.91%, dinocap 76.07% and diphenconazole 75.78%. Among the plant extract behada 5% exhibited higher efficiency showing 66.45% inhibition of conidial germination, followed by tapioca 5% (64.33%) and sadafuli 5% (59.84%).

Though behada extract was inferior to tridemorph in inhibiting the spore germination but it was on par with rest of the chemical fungicides and was equally effective in reducing the spore germination.

As regards the bioagent *Pseudomonas fluorescens*, it had 63.93% inhibition of conidial germination. Bioagent *Pseudomonas* was found less effective than that of tridemorph but it was also at par with rest of fungicides.

Similar findings were reported by Devi and Samy (1984), Singh *et al.* (1999), Tripathi *et al.* (2001) observed tridemorph among fungicides and behada among plant extract had maximum inhibition of spore *in vitro* closely related with the results of present investigation. Dod and Deshmukh (2003) reported the efficiency against *Erysiphe polygoni* DC with eight fungicides and stated that dinocap (0.1%) tridemorph (0.05%) and thiophanate methyl (0.2%) gave highest per cent inhibition of spore germination. Gupta (2001) reported tapioca extract as on useful in inhibiting conidial germination.

#### **4.7 Effect of fungicides, plant extracts and bioagent culture filtrate on different yield attributing characters**

The influence of fungicide, plant extracts and bioagent culture filtrate spray was assessed on powdery mildew epidemics caused by *Erysiphe polygoni* on yield attributing characters like number of pods/plant, pod weight /5 plant and grain weight/5 plant and results are given in Table 10.

**Table 10. Effect of fungicides, plant extracts and bioagent culture filtrate of bioagent on different yield attributing characters**

Treatment	No. of pods per plant	5 plant pod weight (g)	5 plant grain weight (g)
Tridemorph (0.05%)	16.93	42.88	30.79
Dinocap (0.1%)	15.07	32.76	22.76
Propiconazole (0.05%)	16.27	45.11	32.77
Penconazole (0.05%)	17.27	41.2	31.44
Diphenconazole (0.1%)	12.80	43.41	32.43
Hexaconazole (0.1%)	12.53	37.61	24.90
Wettable sulphur (0.3%)	12.27	29.37	21.41
Benomyl (0.2%)	12.40	30.35	21.37
Tapioca extract (5%)	12.87	32.39	24.06
Behada extract (%)	14.80	44.26	31.57
Eucalyptus extract (5%)	11.20	36.18	25.13
Sadafuli extract(5%)	11.27	32.67	22.97
Parthenium extract(5%)	15.67	42.75	32.15
<i>Pseudomonas fluorescens</i> (5%)	11.73	35.27	24.95
Control	10.53	23.17	17.37
'F' test	Sig.	Sig.	Sig.
SE(m)±	1.53	3.14	2.22
CD P=0.5	4.46	9.11	6.45

It is revealed from Table 10 that there was significant differences in all treatments in number of pods per plant, pod weight per 5 plant and grain weight per 5 plant.

As regards number of pods per plant highest number of pods per plant (17.27) were recorded in penconazole ( 0.05%) followed by tridemorph (0.05%) (16.93). Among plant extract highest 15.67 pods/ plant

were recorded in parthenium extract 5% and culture filtrate of *Pseudomonas fluorescens* 5% recorded 11.73 pods per plant.

As regard pod weight maximum weight of pods/5 plant were recorded in propiconazole (0.05%) 45.11 g followed by behada extract (5%) 44.26 g. Culture filtrate of *Pseudomonas fluorescens* (5%) recorded 35.27 g weight of pods/5 plant. The least weight was recorded in control 23.77 g.

In general yield attributing parameters i.e. grain weight/5 plant maximum weight 32.77 g was found in propiconazole (0.05%) followed by diphenconazole ( 0.1%) 32.43 g, whereas in plant extract parthenium extract (5%) recorded highest 32.15 g grain weight and culture filtrate of *Pseudomonas fluorescens* (5%) recorded 24.95 g weight of grain /5 plant and the least grain weight was recorded in control (17.37 g).

Agrawal and Philips ( 1983) reported three sprays of wettable sulphur for increasing the number of pods per plant. Ayub *et al.* (1996) reported the yield contributing parameters like number of pods per plant, number of grains per pod, 100 grain weight and grain yield were significantly higher in fungicide sprayed plant as compared to unsprayed plants. Saxena and Saxena ( 2002) also found that fungicidal spray influenced the yield attributing characters besides controlling disease.

#### **4.8 Control of powdery mildew of green gram *in vivo***

Eight fungicides tridemorph, dinocap, penconazole, propiconazole, diphenconazole, hexaconazole, wettable sulphur and benomyl, five leaf extracts viz. tapioca, behada, eucalyptus, sadafuli and parthenium and culture filtrate of *Pseudomonas fuorescens* were tested against green gram powdery mildew in field conditions. The results on efficiency and yield are presented in Table 11 and graphically illustrated in Fig.10 and 11.

**Table 11. Effect of different fungicides, plant extracts and culture filtrate of bioagent on powdery mildew and yield of green gram**

Treatment details	After 1 <sup>st</sup> spray		After 2 <sup>nd</sup> spray		Grain yield (g/plot)	Grain yield (kg/ha)	% increase in yield
	PDI	PDC	PDI	PDC			
Tridemorph (0.05%)	12.88 (3.59)	50.01	8.44 (2.90)	69.11	383.33	532.40	63.11
Dinocap (0.1%)	15.99 (4.00)	37.95	8.66 (2.94)	68.30	254.33	353.23	8.22
Propiconazole (0.05%)	13.77 (3.71)	46.56	11.55 (3.40)	57.73	328.33	456.01	39.71
Penconazole (0.05%)	11.10 (3.33)	56.91	9.10 (3.02)	66.70	400.00	555.55	70.21
Diphenconazole (0.1%)	11.10 (3.33)	56.92	8.44 (2.90)	69.11	391.66	543.97	66.66
Hexaconazole (0.1%)	12.66 (3.56)	50.87	9.32 (3.05)	65.89	316.66	439.80	34.74
Wettable sulphur (0.3%)	12.22 (3.50)	52.58	8.88 (2.98)	67.50	356.66	495.36	51.77
Benomyl (0.2%)	12.66 (3.56)	50.87	9.77 (3.13)	64.25	256.00	355.55	8.93
Tapioca extract (5%)	15.11 (3.89)	41.36	11.99 (3.46)	56.12	348.33	483.79	48.22
Behada extract (5%)	12.66 (3.56)	50.87	11.55 (3.40)	57.73	323.33	449.06	37.58
Eucalyptus extract (5%)	12.88 (3.59)	50.01	13.10 (3.62)	52.06	293.33	407.40	24.82
Sadafuli extract(5%)	15.10 (3.88)	41.40	11.77 (3.43)	56.93	335.00	465.27	42.55
Parthenium extract(5%)	15.33 (3.91)	40.51	11.77 (3.43)	56.93	393.33	546.29	67.37
<i>Pseudomonas fluorescens</i> (5%)	12.88 (3.89)	50.01	13.33 (3.65)	51.22	308.33	428.23	31.20
Control	25.77 (5.08)	-	27.33 (5.23)	0	235.00	326.38	-
'F' test	Sig.		Sig.		NS	NS	
SE(m)±	0.19		0.15		50.46	70.08	
CD P=0.05	0.55		0.42				

Figures in parenthesis are square root value

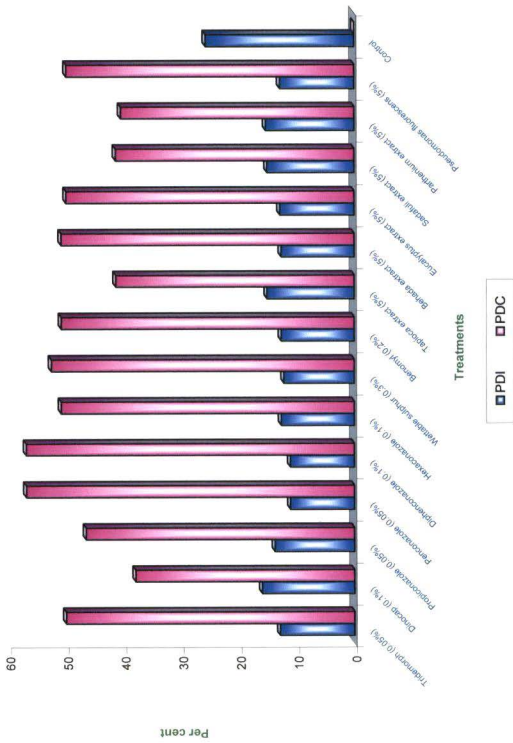
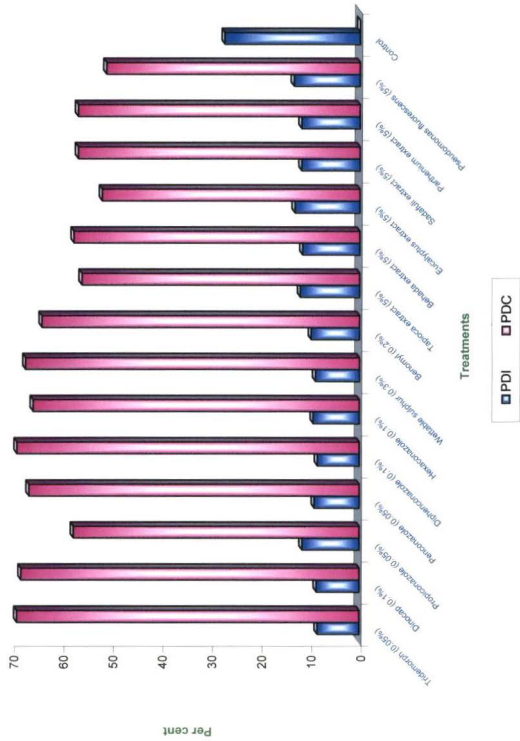


Fig.10. Per cent disease intensity (PDI) and per cent disease control (PDC) due to various treatments in green gram after 1st spraying



**Fig.11. Per cent disease intensity (PDI) and per cent disease control (PDC) due to various treatments in green gram after 2nd spraying**

Data presented in Table 11 indicated that the fungicides, plant extracts and culture filtrate gave significant reduction of powdery mildew disease and increased yield. After second spray minimum per cent disease intensity was recorded in tridemorph 0.5% (8.44%) and diphenconazole 0.1% (8.44%) which was followed by dinocap 0.1% (8.66%). Among the plant extract behada 5% extract recorded 11.55 PDI which was at par with propiconazole 0.05%. Bioagent *Pseudomonas fluorescens* recorded 13.33 per cent disease intensity which was quite lower than that of control. Maximum per cent disease intensity was recorded in control (27.33). Maximum disease reduction after 1<sup>st</sup> spray was observed in penconazole (topas) 0.05% and diphenconazole (score) 0.1% i.e. (56.92%) followed by wettable sulphur (sulfil) 0.3% (52.58%). Hexaconazole (contaf) 0.1%, benomyl (benlate) 0.2%, tridemorph (calixin) 0.05%, propiconazole (tilt) 0.05% and dinocap (karathane) 0.1% with 50.87%, 50.87%, 50.01%, 46.56% and 37.95% disease reduction respectively. Among plant extract maximum disease reduction was observed in behada leaf extract 50.87% followed by eucalyptus leaf extract 50.01%. Sadafuli extract 5%, tapioca extract 5% and parthenium extract 5% which showed 41.40%, 41.36% and 40.51% reduction in disease respectively. Culture filtrate of *Pseudomonas fluorescens* reduced 50.01% disease in field condition after 1<sup>st</sup> spray.

After second spray maximum disease reduction observed in diphenconazole and tridemorph 69.11% each followed by dinocap (68.30%), wettable sulphur (67.50%), penconazole (66.70%), hexaconazole (65.89%) and benomyl (64.25%).

Among plant extract maximum disease reduction was observed in behada extract 57.73% followed by sadafuli, parthenium, tapioca and eucalyptus showed 56.93%, 56.93%, 56.12% and 52.06% disease reduction respectively. Culture filtrate of *Pseudomonas fluorescens* reduce 51.22% powdery mildew of green gram.

Maximum yield was obtained in spray of penconazole and the percentage increase in yield over control was 70.21% followed by

diphenconazole, tridemorph, wettable sulphur, propiconazole, hexaconazole, benomyl and dinocap with 66.66%, 63.11%, 51.77%, 39.71%, 34.74%, 8.93% and 8.22% increase in yield over control respectively. In plant extract maximum yield was obtained in parthenium extract 67.37% followed by tapioca extract 48.22%, sadafuli extract 42.55%, behada extract 37.58% and eucalyptus extract 24.82%. Culture filtrate of bioagent *Pseudomonas fluorescens* showed 31.20% increase yield over control.

Fungicidal sprays proved better than plant extract and bioagent in disease reduction and increasing yield. The results obtained in many cases are quite comparable to that of effective fungicides found in present investigation reported by. Singh and Singh (1983), Singh *et al.* (1991), Sindhan *et al.* (1999), Singh *et al.* (1999). In the present studies extract of tapioca, behada, eucalyptus, sadafuli and parthenium reduced the disease and increased the yield but compared to fungicidal sprays proved inferior. Behada extract proved better and minimized the disease by 57.12% and enhanced yield by 37.58%. This indicated that fungicides have still a upper hand over plant extract sprays to reduce the powdery mildew.

Present results are comparable to Sindhan *et al.* (1999), Gupta (2001), Baravkar (2001) and Dhakre (2003). Tridemorph (calixin) as systemic fungicide reported as effective against powdery mildew of green gram, black gram and pea by earlier workers.

### **Tridemorph (Calixin)**

Singh and Naik (1977), Khatua *et al.* (1978), Bharadwaj and Sharma (1984), Krishnamohan *et al.* (1986), Mehta and Suhag (1986), Raut *et al.* (1986), Khosla *et al.* (1988), Begum (1989), Kunkalikar and Padaganur (1990), Setty (1996), Naik (2000), Tripathi (2001), Saxena and Molysaxena (2002), Khunti *et al.* (2002), Kunkalikar and Padaganur (2002), Dhakre (2003) reported the higher efficiency of tridemorph.

In the present investigation it was evident that tridemorph and diphenconazole were better than penconazole in disease reduction

whereas in yield penconazole was found better than diphenconazole and tridemorph.

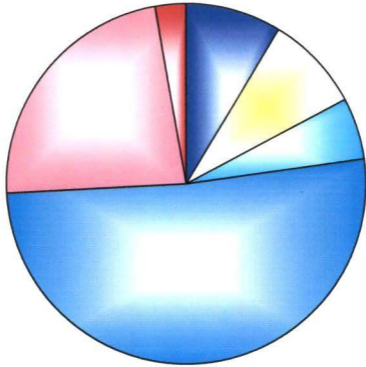
#### 4.9 Reaction of green gram cultivar to powdery mildew

Thirty five entries of green gram were tested against powdery mildew under natural field conditions during *kharif* 2008 at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and the entries were rated as highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible. The results are presented in Table 12 and graphically illustrated in Fig. 12.

Out of 35 entries of green gram, 3 entries viz., (BPMR-48, BPMR-146, BPMR-207) were found highly resistant to powdery mildew. Entries TARM-2, TARM-18, BPMR-75 exhibited resistant reaction against the disease and two entries Vaibhav and BPMR-145 were found moderately resistant. Eighteen entries were moderately susceptible, 8 entries susceptible and Kopergaon was found highly susceptible to the powdery mildew.

**Table 12. Reaction of different cultivars / entries of green gram to powdery mildew under natural field conditions**

Grade	Reaction	No. of entries	Cultivars /Entries
0	Highly resistant	3	BPMR-48, BPMR-146, BPMR-207
1	Resistant	3	BPMR-75, TARM-2, TARM-18
2	Moderately resistant	2	BPMR-145, Vaibhav
3	Moderately susceptible	18	AKM-0601, AKM-0605, AKM-0802, AKM-0810, AKM-0801, AKM-9801, AKM-9907, AKM-9911, AKM-9914, AKM-07-227, BM-4, BM-2005-1, BM-2003-2, PM-2001-23, PM-2002-20, PM-2002-48, TAM-99-38, TAM-2001-7
4	Susceptible	8	AKM-0603, AKM-8802, AKM-9910, AKM-07-204, AKM-07-211, BM-2004, BM-2002-1, JLM-7
5	Highly susceptible	1	Kopergaon



■ Highly resistant	□ Resistant
■ Moderately resistant	■ Moderately susceptible
□ Susceptible	■ Highly susceptible

**Fig.12. Reaction of various cultivars of green gram against powdery mildew**

It is evident that powdery mildew causes considerable reduction in grain yield of green gram. Though chemical approach for disease management is recommended it involves higher cost of cultivation and also the pollution. Use of resistant variety to powdery mildew remains the only practical and economically feasible solution. Several sources of resistant to powdery mildew have been reported by different workers in green gram. Gangadharan *et al.* (1983) screened 380 varieties of green gram against powdery mildew and recorded 170 entries as resistant. Reddy *et al.*(1987) recorded 7 rum accessions resistant out of 55 mungbean accessions

Agrawal and Nema (1989) found 2 accessions (ML-223 and ML-395) most resistant out of 170 accessions of green gram, Patil *et al.* (1989) recorded only one variety as moderately resistant out of 40 cultivars of green gram. Laxmipathi *et al.* (1993) recorded one (ML-3) resistant out of 45 genotypes of green gram. Patil and Moghe (1993) recorded 4 varieties resistant out of 10 varieties of green gram.

Pawar *et al.*(1995) recorded only one variety (TARM-18) as a resistant out of 50 varieties of green gram Khare and Lakpale (1997) found 7 varieties moderately resistant out of 19 mung bean varieties, Gupta (2001) recorded 6 entries (TARM-2, AKM-9242, TARM-18, PM-9338, AKM-9902 and BPMR-145) which exhibited resistant reaction against powdery mildew of green gram, Kunkaliker and Padaganur (2002) recorded only 3 (Black green gram, Cob-g-co-4 and Bgg-2) were resistant out of 90 cultivars of green gram. Mandhare and Suraywanshi (2008) recorded 5 varieties (Vaibhav, BPMR-145, TARM-18, Phule-M-2001-3 and Phule-M-2001-5) exhibited resistant reaction out of 82 genotypes against powdery mildew of green gram and yellow mosaic virus. Different workers have reported a set of culture with varied type of reaction in different geographical areas might be due to existence of races in the powdery mildew pathogen i.e. *Erysiphe poligoni*. Moreover, some of the varieties reactions are on the line present studies.

## CHAPTER V

### SUMMARY AND CONCLUSIONS

Among pulses green gram (*Vigna radiata* (L.) Wilczek) is the most important pulse crop grown throughout India. In terms of area cultivated and production, it is short duration low input, requirement crop and quite economical in cultivation and fixes atmospheric nitrogen.

Green gram suffers from many foliar diseases and among them powdery mildew caused by *Erysiphe polygoni* DC is major destructive disease. It appears in epidemic form almost every year in varying intensity leading to greater yield losses. Many of the varieties are reported susceptible to the disease.

Therefore, it was necessary to obtain the information on disease initiation, epidemiology, alteration in sowing time and management by using fungicides, plant extract and culture filtrate and to ascertain the resistant varieties.

During *kharif* season first initiation of the disease recorded in the field during 31<sup>st</sup> meteorological week at 24 to 29.7°C temperature and 74 to 90% relative humidity, while rainfall was 27.6 mm. For the progression and manifestation of the disease requisite maximum temperature range was 29.7 to 32.5°C and minimum temperature ranged between 22.6 to 24.0°C was found to be favourable. Similarly morning relative humidity range 81 to 94% and evening RH range of 56 to 71% was found favourable for the disease development. Wind velocity in the range of 1.8 to 8 km/hr and sunshine hours of 3.9 to 5.9 and rainfall 3.3 to 87.7 mm favoured the disease development.

Different ranges of temperature, relative humidity, light and darkness were studied *in vitro*. Conidial germination was maximum at 25°C followed by 30°C. Per cent conidial germination was maximum at 80 to 90% relative humidity. For the development of the disease 24 hr light was found to be favourable as evident by the maximum conidial germination.

Disease intensity had a direct effect on the reduction in grain yield in Kopergaon variety. Highest reduction i.e. 48% yield losses were observed when the intensity of disease was more than 75%.

As regards the initiation of disease with respect to sowing dates, disease appeared slightly late i.e. 35 days after sowing when highly susceptible green gram variety Kopergaon was sown on (01.07.08) while late sown crop (08.07.08), (15.07.08) and (22.07.08) prone to disease after 28, 21 and 14 days after sowing respectively.

Maximum disease intensity was recorded on late sown crop i.e. 38.79% while early sown crop showed minimum intensity than late sowing and its effect on maximum grain yield was obtained when the sowing was done late. Early on timely sowing gave normal yield with minimum disease intensity.

Maximum number of pods per plant, pod weight /5 plant and grain weight / 5 plant observed in 1<sup>st</sup> date of sowing (1<sup>st</sup> July) while it will be reduced at the 2<sup>nd</sup> (8<sup>th</sup> July), 3<sup>rd</sup> (15<sup>th</sup> July) and least were recorded at the 4<sup>th</sup> (22<sup>nd</sup> July) date of sowing.

Higher inhibition of spore germination was recorded in tridemorph (0.05%) and it was significantly higher over other treatments. Wettable sulphur (0.3%) was next superior fungicides. Plant extracts proved less effective as compared to fungicides, however Behada extract (5%) recorded maximum spore inhibition followed by tapioca extract (5%) and culture filtrate of *Pseudomonas fluorescens* (5%) also reduced spore germination.

Two sprays of fungicides, plant extracts and bioagent were applied, first after initiation of disease and second seven days after first spray was proved more effective in reducing disease intensity and increasing yield.

As regard the yield attributing characters maximum number of pods per plant was more in penconazole 0.05% whereas pod weight per plant and grain weight /5 plant was recorded in spray of propiconazole 0.05%.

Among plant extract Parthenium 5% was effective in recording maximum number of pods per plant and grain weight /5 plant whereas Behada 5% recorded highest weight pod/5 plant

Tridemorph (0.05%) and diphenconazole (0.1%) both proved superior in reducing the disease followed by dincap (0.1%) and wettable sulphur (0.3%). Among plant extract Behada extract (5%) proved superior followed by Parthenium (5%), Eucalyptus (5%), Tapioca (5%), and Sadafuli (5%). Culture filtrate of *Pseudomonas fluorescens* (5%) also significantly reduced disease intensity over control. Thus two sprays of tridemorph and diphenconazole first at the initiation of disease followed by second after 7 days were efficient for management of green gram powdery mildew.

As regards grain yield highest yield was recorded (555.55 kg/ha) in penconazole (0.05%) followed by diphenconazole 0.1% (543.97 kg/ha). Among plant extract parthenium extract 5% (546.29 kg/ha) recorded highest yield followed by tapioca extract 5% (483.79 kg/ha) and culture filtrate of *Pseudomonas fluorescens* recorded (428.23 kg/ha).

Three varieties viz., BPMR-48, BPMR-146, BPMR-207 showed highly resistant reaction while 3 varieties i.e. BPMR-75, TARM-2, TARM-18 were categorized as resistant against powdery mildew of green gram.

## CONCLUSIONS

1. Early sown crop showed less disease intensity than that of late sown crop.
2. Two meteorological parameters viz., sunshine hours and wind velocity of preceding week whereas minimum temperature and wind velocity of current week showed positive correlation with the disease development.
3. *In vitro* 25°C to 30°C temperature was found optimum for conidial germination.
4. High relative humidity 80 to 90% was found better for conidial germination.
5. Continuous light favoured the conidial germination.

6. Disease attend higher level at crop maturity.
7. Yield losses in powdery mildew of green gram are praportional to the disease intensity. The maximum losses i.e. 48 per cent were recorded at more than 75 per cent disease intensity.
8. Tridemorph 0.05% found efficient in reducing the conidial germination.
9. Behada 5% extract and bioagent *Pseudomonas fluorescens* found better and substitute to chemical fungicides.
10. Maximum per cent disease reduction was obtained in two sprays of tridemorph 0.05% and diphenconazole 0.1%.
11. Highest grain yield was recorded in penconazole 0.05% and diphenconazole 0.1%.
12. Green gram BPMR-48, BPMR-146 and BPMR-207 recorded highly resistant reaction against powdery mildew.



## CHAPTER VI

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\* Original not seen

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Place: Akola

Date: 10/06/2009

  
Signature of student

## APPENDIX –I

Chemical fungicide, botanicals and bioagent used *in vitro*  
concentration

Sr. No.	Chemicals	Trade name	Concentration (%)
1	Tridemorph	Calixin	0.05
2	Dinocap	Karathane	0.1
3	Penconazole	Topas	0.05
4	Propiconazole	Tilt	0.05
5	Diphenconazole	Score	0.1
6	Hexaconazole	Contaf	0.1
7	Wettable sulphur	Sulfil	0.30
8	Benomyl	Benlate	0.2
	<b>Botanicals</b>	Botanical name	
9	Tapioca extract	<i>Manihot utilissimum</i>	5
10	Behada extract	<i>Terminalia belerica</i>	5
11	Eucalyptus extract	<i>Eucalyptus globulus</i>	5
12	Parthenium extract	<i>Parthenium hysterophorus</i>	5
13	Sadaphuli extract	<i>Vinca rosea</i>	5
	<b>Bioagents</b>		
14	<i>Pseudomonas fluorescens</i>		5
15	Control		

## APPENDIX –II

### 1. Media used

#### King's 'B' broth

- a. Protease peptone - 20 g
- b. Dipotassium hydrogen phosphate - 1.5 g
- c. Magnesium sulphate 7 H<sub>2</sub>O - 1.5 g
- d. Glycerol 15 ml

## APPENDIX –III

Soloman (1951) maintained humidity levels in desicator by using a mixture of concentrated sulphuric acid + distilled water as follows.

RH % at 25 <sup>0</sup> C	Wt % (g H <sub>2</sub> SO <sub>4</sub> per 100 g solution)
90	17.91
80	26.79
70	33.09
60	38.35
50	43.10
40	47.71
30	52.45

## APPENDIX-IV

**Table 1. Weekly weather data for the year 2008 and 2009 recorded at Meteorological Observatory Department of Agronomy, Dr. PDKV, Akola**

Actual 2008  
Normal : 1971-2000

Met week	Dates	Temp. max. (°C)		Temp. 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	
	<b>2008</b>																				
1	1-7 Jan	29.0	29.6	10.3	14.5	8.7	8.8	4.9	2.4	78	86	30	35	4.2	3.9	1.7	19.5	19.5	0.2	2.00	
2	8-14	29.2	30.4	11.3	13.1	8.6	7.7	6.3	0.7	71	82	30	31	4.5	3.7	3.4	0.0	19.5	0.2	0.00	
3	15-21	29.9	30.7	11.6	12.7	8.9	8.4	5.4	1.3	69	74	28	25	4.8	4.8	0.9	0.0	19.5	0.1	0.00	
4	22-28	30.8	26.9	11.8	9.2	9.1	8.0	5.5	2.7	67	70	27	22	5.2	5.2	1.1	0.0	19.5	0.2	0.00	
5	29-4 Feb	31.1	27.4	12.1	10.7	9.3	8.5	5.8	3.1	61	58	25	21	5.6	5.4	2.8	0.0	19.5	0.2	0.00	
6	5-11	31.3	26.0	11.9	11.7	9.1	7.0	5.6	4.7	59	50	23	26	5.9	5.8	4.9	0.0	19.5	0.4	0.00	
7	12-18	32.5	31.5	13.4	13.8	9.4	8.1	6.1	2.6	56	55	22	22	6.6	6.5	0.1	0.0	19.5	0.0	0.00	
8	19-25	33.0	34.3	13.8	14.3	9.5	8.6	6.5	1.9	57	55	22	21	7.3	6.5	3.3	0.0	19.5	0.5	0.00	
9	26-04 Mar	34.7	34.7	14.8	13.3	9.6	8.8	7.0	1.7	50	51	17	20	8.1	7.2	3.4	0.0	19.5	0.3	0.00	
10	5-11	36.1	37.9	16.7	17.5	9.6	8.0	6.8	1.1	44	48	18	18	9.0	7.7	2.1	0.0	19.5	0.3	0.00	
11	12-18	37.3	38.0	17.5	20.6	9.6	7.3	6.9	3.4	42	46	17	22	9.5	9.8	2.5	0.0	19.5	0.3	0.00	
12	19-25	38.5	36.0	18.3	22.7	9.6	6.4	6.9	4.5	37	70	13	33	10.5	7.5	0.3	14.2	33.7	0.1	1.00	
13	26-1April	39.0	37.6	19.7	22.2	9.6	6.9	7.6	2.4	36	54	15	20	11.3	8.5	2.9	0.3	34.0	0.3	0.00	
14	2-8	40.1	36.4	21.1	22.1	9.8	8.7	7.9	5.3	36	55	15	23	11.7	10.1	0.6	0.0	34.0	0.1	0.00	
15	9-15	40.8	40.3	22.5	23.6	9.9	8.3	9.3	3.3	34	36	12	16	13.4	10.7	0.3	0.0	34.0	0.1	0.00	
16	16-22	41.7	42.5	23.5	25.5	10.2	9.4	9.1	5.8	34	36	14	17	13.7	14.0	0.3	0.0	34.0	0.0	0.00	
17	23-29	42.1	44.3	24.8	26.1	10.1	9.5	10.2	4.4	37	44	14	16	14.4	14.1	0.0	0.0	34.0	0.1	0.00	
18	30- 6 May	42.7	42.6	26.0	27.6	9.9	9.1	11.4	13.3	38	49	14	21	15.4	18.0	0.3	0.0	34.0	0.2	0.00	
19	7-13	42.6	40.6	26.5	27.8	10.1	9.6	12.7	11.6	43	52	17	24	16.4	16.0	0.3	0.0	34.0	0.1	0.00	
20	14-20	42.6	41.2	27.3	27.8	9.7	10.0	14.6	15.4	48	53	18	23	17.3	17.6	1.8	0.0	34.0	0.2	0.00	
21	21-27	42.4	41.5	27.4	28.7	9.8	9.8	15.7	11.8	50	49	20	23	17.0	16.3	4.1	0.0	34.0	0.5	0.00	
22	28-3 Jun	41.9	41.7	27.6	29.5	9.7	9.7	16.2	12.0	56	44	23	22	16.3	16.7	5.7	0.0	34.0	0.5	0.00	
23	4-10	39.0	38.8	25.8	26.2	8.0	6.7	14.9	7.5	62	63	30	33	13.4	10.5	18.3	23.6	57.6	1.2	2.00	
24	11-17	38.2	35.3	25.5	25.2	7.5	2.9	15.4	11.6	71	69	42	39	11.1	8.8	43.3	5.0	62.6	2.0	1.00	
25	18-24	35.3	35.1	24.9	27.4	7.1	0.9	15.1	15.0	76	61	50	40	9.1	10.4	52.3	0.5	63.1	2.2	0.00	
26	25-1Jul	34.1	30.9	24.2	25.6	5.3	1.1	13.4	7.1	80	82	55	69	7.3	4.7	38.2	48.1	111.2	2.3	3.00	
27	2-8	33.5	32.7	24.4	24.7	5.2	3.1	12.9	10.2	81	79	58	53	6.8	6.3	34.7	20.8	132.0	2.4	2.00	
28	9-15	32.3	31.7	23.7	24.7	3.8	3.4	12.0	10.7	84	78	62	52	5.5	6.0	52.2	1.6	133.6	2.8	0.00	
29	16-22	32.0	34.6	23.9	26.1	3.3	5.3	11.2	9.0	84	76	65	43	5.6	8.3	58.6	57.2	190.8	2.6	2.00	
30	23-29	31.7	31.7	23.3	23.8	4.3	2.7	11.9	7.6	85	93	64	67	5.3	5.0	44.2	55.2	246.0	2.6	6.00	
31	30-5 Aug	31.1	29.7	23.1	24.0	3.6	2.0	11.7	10.1	88	90	66	74	4.6	2.9	49.3	27.6	273.6	2.5	3.00	

Contd...

Met week	Dates	Temp. max. (°C)		Temp. 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
32	6-12	30.2	27.8	22.9	23.5	3.5	0.3	11.6	11.8	87	90	69	79	4.2	2.3	59.9	62.6	336.2	2.9	4.00
33	13-19	30.5	31.1	22.8	23.9	4.4	3.9	11.7	8.0	86	85	66	60	4.5	4.4	40.6	3.3	339.5	2.2	1.00
34	20-26	30.5	32.5	22.6	24.0	4.3	5.9	11.0	7.4	88	81	66	58	4.3	5.5	46.7	13.6	353.1	2.0	1.00
35	27-2 Sep	30.4	31.9	22.7	23.6	4.4	4.3	10.6	2.1	86	91	84	56	4.2	3.9	47.1	11.9	365.0	2.4	2.00
36	3-9	31.1	31.8	22.5	23.2	5.7	5.0	9.1	1.8	85	94	81	63	4.7	4.3	28.5	61.4	426.4	1.5	3.00
37	10-16	32.2	30.6	22.4	22.7	7.1	5.0	9.0	4.1	85	94	56	70	5.1	4.2	18.9	87.7	514.1	1.1	7.00
38	17-23	33.4	29.7	22.3	22.6	7.2	4.0	8.5	5.3	83	91	53	71	5.3	3.7	24.6	25.1	539.2	1.4	3.00
39	24-30	33.7	31.2	21.9	21.7	7.6	8.1	5.4	4.8	83	88	50	55	4.9	5.0	24.4	0.0	539.2	1.5	0.00
40	1-7 Oct	33.9	33.8	20.2	22.6	8.1	7.2	7.5	1.6	81	84	45	49	5.5	5.1	21.8	0.0	539.2	1.1	0.00
41	8-14	34.1	33.4	18.7	20.7	4.2	7.0	4.1	1.3	76	88	40	40	5.3	4.4	16.0	18.0	557.2	0.9	1.00
42	15-21	33.9	34.3	18.1	18.2	8.4	8.4	4.4	1.5	74	76	36	27	5.5	5.6	3.1	0.0	557.2	0.4	0.00
43	22-28	33.1	33.6	18.5	14.5	8.4	8.7	4.1	1.5	73	71	36	18	5.3	5.7	10.0	0.0	557.2	0.6	0.00
44	29-4 Nov	33.0	34.6	15.8	15.8	8.7	8.7	4.7	0.8	72	68	31	19	5.3	5.1	2.3	0.0	557.2	0.3	0.00
45	5-11	32.4	33.4	14.8	15.4	8.6	8.2	4.5	0.7	70	70	30	26	5.2	4.7	3.7	0.0	557.2	0.3	0.00
46	12-18	31.7	31.8	13.7	17.8	8.6	4.9	4.6	1.9	70	70	30	35	4.9	4.7	1.1	0.0	557.2	0.2	0.00
47	19-25	31.0	32.7	13.1	17.1	8.6	7.6	4.4	1.5	71	85	30	35	4.6	4.6	10.1	5.0	562.2	0.3	1.00
48	26-2 Dec	30.3	30.8	12.4	15.4	8.8	5.5	4.6	3.2	71	65	31	29	4.3	5.4	6.8	0.5	562.7	0.3	0.00
49	3-9	29.8	32.5	11.2	14.0	8.7	7.5	4.7	2.3	70	58	29	18	4.3	5.8	1.3	0.0	562.7	0.2	0.00
50	10-16	29.4	32.1	10.3	15.8	8.8	5.2	4.5	1.4	70	70	27	32	4.2	5.1	1.3	0.0	562.7	0.2	0.00
51	17-23	29.5	31.6	10.6	13.8	8.7	6.4	4.7	2.1	69	64	29	25	4.3	5.4	0.9	0.0	562.7	0.1	0.00
52	24-31*	29.2	30.2	10.7	9.4	8.6	6.9	4.8	1.0	70	64	31	16	4.3	4.5	2.6	0.0	562.7	0.2	0.00

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