Plant Archives Vol. 17 No. 1, 2017 pp. 171-176 *ISSN 0972-5210*

EPIDEMIOLOGICAL STUDIES ON POWDERY MILDEW OF VEGETABLE PEA

Upendra Kumar Nag* and C. P. Khare

Department of Plant Pathology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur-492 006 (C.G.), India.

Abstract

The disease epidemiology of Pea Powdery mildew caused by *Erysiphe pisi* DC was studied during 2013-14 winter/spring season. The results revealed that, the first appearance of powdery mildew was observed 1st week earlier in variety Pant Vegetable Pea and Azad-P-3 during winter 2013-14. *Erysiphe pisi* DC can grow at wide range of temperatures during the cropping period having maximum temperature ranges from 27.6^{0}C to 30.6^{0}C and minimum temperature from 9.7^{0}C to 16.7^{0}C. The pathogen required high relative humidity during morning ranged from 83% to 93% and relative humidity during evening ranged from 23% (5th SMW 2014) to 47% (2nd SMW 2014). Increase in PDI was maximum in temperature ranges from 28.5-30.0^{0}C (maximum) and 13.1-14.2^{0}C (minimum) temperature, wind velocity 1.6 Kmph and 68% average relative humidity. A positive correlation occurred between powdery mildew severity and temperatures, wind velocity in the varieties. However, the correlation with relative humidity was negative and significant except in varieties.

Key words : Relative humidity, wind velocity, Erysiphe pisi, powdery mildew.

Introduction

Pea is an important, cool-season, nutritious leguminous vegetable that is widely cultivated throughout the world. It belongs to the family (Fabaceae) Leguminosae. "*Pisum sativum* L." sub species "Hortense" originated from common field pea. Due to its very old history of domestication, versatile use as vegetables, pulses and feed, it is important food legumes in the world (Choudhury *et al*., 2006). In India, vegetable pea is grown in about 0.37 million ha with annual production of 3.571 million tonnes. In Chhattisgarh, the total area under vegetable pea is 0.01 million ha and production is 0.09 million tonnes (Horticulture Data Base, 2013). The production has been constrained by several yield limiting factors such as powdery mildew, poor soil fertility and unimproved cultural practices (Saxesena *et al*., 2014). Pea in most important diseases is Powdery mildew, caused by *Erysiphe pisi* DC is a destructive pathogen causing infection on all the above ground parts of pea plants (Singh, 2000) and occurs in epidemic proportions during the winter/spring season. Yield reduction due to these diseases is very high within short period of time Infection of peas by powdery mildew (*Erysiphe pisi*) reduces transpiration and initially increases the water potential and relative water content of tissues. This disease usually appear late in the season, reaching maximum intensity during the pod formation stage. In the Chhattisgarh region of the central part of India, resulting in varying degrees of yield loss. The pathogen causes up to 50% losses and reduces pod quality (Nisar *et al*., 2006; and Dixon, 1987). Powdery mildew remains a serious problem in all the rice-based cropping systems of Chhattisgarh, Andhra Pradesh, Madhya Pradesh and Orissa. Powdery mildew generally appears from the early flowering to the pod maturity stage and its development depends upon the cultivars used, growing period and environmental conditions. The pathogen flourishes with dewy nights and warm days with the optimum temperature for conidial germination being 20°C. Information on powdery mildew of pea during the monsoon season (warm, wet season) is available but precise data on powdery mildew occurring during winter season (cool, dry) are lacking. Considering the nature of damage and survival ability of the fungus, the use of biocontrol agents and resistance pea accessions were considered is good option. There is a pressure from environmentalist that reducing the use of fungicides due to its negative effect in plant ecosystem (Ali *et al*., 2014). Our objective is to find out the durable source of resistance and understand the rates of powdery mildew development

***Author for correspondence :** E-mail: upnag69@gmail.com

with respect to crops, varieties, weather conditions and their effect on yield with and without protection during the winter/spring season.

Materials and Methods

The field experiment was conducted at the Horticulture Research Farm, IGKV, Raipur (C.G.), India during the winter seasons of 2013-2014. Pant Vegetable Pea and Azad-P-3 variety (highly susceptible to powdery mildew) was shown on 07 November, 2013-14 in a randomized block design with two replication and plot size was of 5 × 1.5 meter. The observation on appearance of powdery mildew was carefully recorded. Thereafter, progress of the disease was recorded at seven days interval and continued until disease severity reaches maximum up to physiological maturity of the crop. Observations of powdery mildew were recorded in the term of percent disease severity. The effects of climatic factors *viz.* temperature, humidity and wind velocity on disease severity were also studied. Thereafter, progress of the disease was recorded at 7-day intervals and continued until crop maturity. Observations on powdery mildew severity were recorded using a 0-5 scale (Munjal *et al*., 1963). On this scale:

Score	Percent disease infection
0	0
1	1-10
2	10.1 – 25
3	25.1- 50
4	50.1-75
5	75.1-above

The meteorological data were collected from meteorology department, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), India. Correlation co-efficient between disease severity and meteorological parameters were determined by Karl Pearson's formula and tested individually for their significance at 5% probability level by using following formula:

$$t = \frac{r(n-2)}{\sqrt{1-r^2}}$$

Where,

f = test of significance

r = correlation coefficient

n = number of observations

The rate of disease development unit/day was estimated according to the method given by Vanderplank (1963). The apparent infection rate (r) for total period was

$$r = \frac{1}{t_1 - t_2} + log\, e\left[\frac{x_2(1-x_1)}{x_1(1-x_2)}\right]$$

Where,

r = rate of disease development

t_1 = date of first observation

t_2 = date of second observation

x_1 = disease severity on first observation

x_2 = disease severity on second observation

To study the effect of weather varying levels on disease development. The average of four replications of 10 plants each from Pant Vegetable Pea and Azad-P-3 with and without protection was taken during winter, 2014. Disease scores were based on 10 randomly selected plants per plot in each.

Replication and the same plants were considered for estimation of disease development on different variety. The average of disease development on different variety per plant basis and calculated as average per plot.

Results and Discussion

Progressive disease development

In the present investigation, disease development in relation to weather parameters was studied during 2013-14. Observations were recorded from 45th standard metrological week (SMW) at weekly intervals till crop harvest.

The first appearance of pea powdery mildew was observed at 33 days after sowing (DAS) subsequently, it developed in linear way. PDI was lowest during 49th SMW (1.2%) and increased throughout the cropping period (table 1 and figs. 1 and 2) and was at peak during last stage i.e., 5th SMW (94.00%). During the cropping period, maximum temperature ranged from 27.5^{0}C (46th SMW 2013) to 30.0^{0}C (45^{th,} 47th and 48th SMW 2013), minimum temperature from 9.8^{0}C (50th SMW 2013) to 16.7^{0}C (45th and 47th SMW 2013), relative humidity during morning ranged from 83% (48th SMW 2013) to 93% (52nd SMW 2013) and relative humidity during evening ranged from 27% (50th SMW 2013) to 47% (2nd SMW 2014). However, wind velocity was very erratic. It ranged from 0.6 Kmph (45th SMW 2013) to 2.5 Kmph (3rd SMW 2014).

From the table, it may be concluded that increase in disease index was comparatively higher during December to January when maximum (27.8^{0}C-28.1^{0}C) and minimum (11.7-14.1^{0}C) temperature and average relative humidity (66%) were most congenial for disease development.

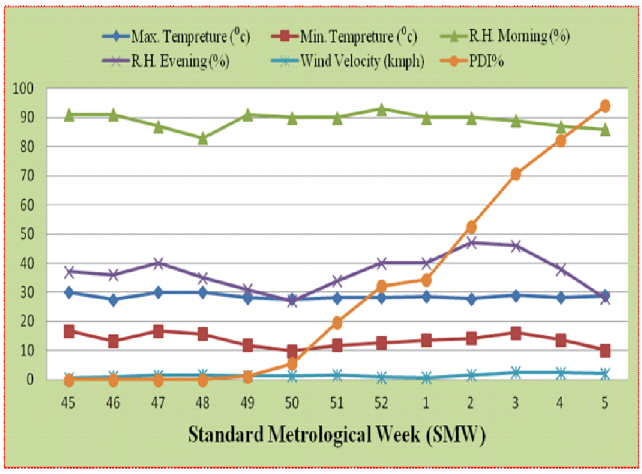

Fig. (a) : Development of PDI of pea powdery mildew and weather parameters associated during *Rabi* 2013-14.

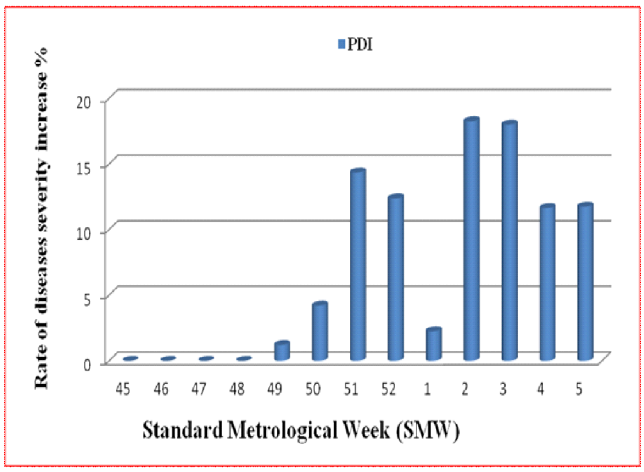

Fig. (b) : Increase in severity index of pea powdery mildew disease during *Rabi* 2013-14.

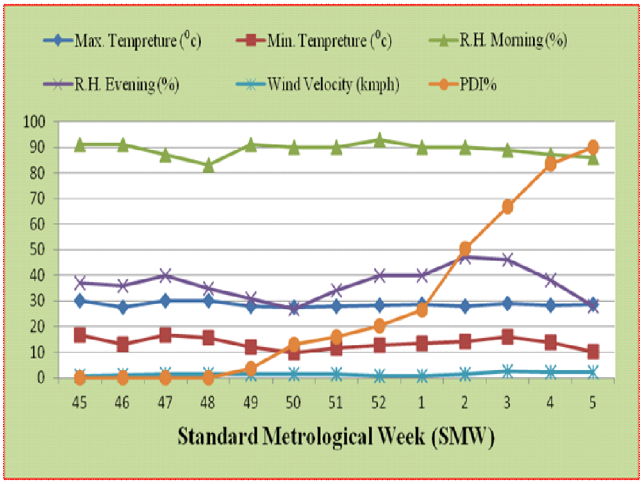

Fig. (c) : Development of PDI of pea powdery mildew and weather parameters associated during *Rabi* 2013-14.

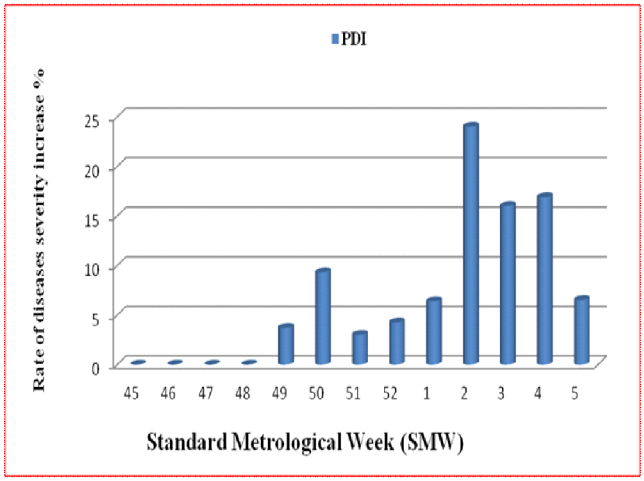

Fig. (d) : Increase in severity index of pea powdery mildew disease during *Rabi* 2013-14.

Kumar and Gupta (2006) studied the influence of environmental factors on the development of pea powdery mildew (*Erysiphe pisi*) under field conditions. Conidial germination and germ tube length recorded a maximum at 25^{0}C. High relative humidity (100%) favoured conidial germination and germ tube length. Under field conditions, temperature played an important role in the disease development. Highly significant and positive correlations were observed between temperature and disease severity during two crop seasons.

Azad-P-3

Azad-P-3 variety powdery mildew was observed at 35 days after sowing (DAS) subsequently, it developed in linear way. PDI was lowest during 49th SMW (3.7%) and increased throughout the cropping period (table 3 and figs. 3 and 4) and was at peak during last stage *i.e.*, 5th SMW (90.0%). During the cropping period, maximum temperature ranged from 27.5^{0}C (46th SMW 2013) to 30.0^{0}C (45^{th,} 47th and 48th SMW 2013), minimum temperature from 9.8^{0}C (50th SMW 2013) to 16.7^{0}C (45th and 47th SMW 2013), relative humidity during morning ranged from 83% (48th SMW 2013) to 93% (52nd SMW 2013) and relative humidity during evening ranged from 27% (50th SMW 2013) to 47% (2nd SMW 2014). However, Wind Velocity was very erratic. It ranged from 0.6 Km/h (45th SMW 2013) to 2.5 Kmph (3rd SMW 2014).

From the table, it may be concluded that increase in disease index was comparatively higher during December to January when maximum (27.8^{0}C-28.1^{0}C) and minimum (11.7^{0}C-14.1^{0}C) temperature and average relative humidity (66%) were most congenial for disease development. These findings are in agreement with the earlier reports. Kachhot *et al.* (2011) observed higher disease index between the periods of January 31-February 27, 2010 with the highest disease (80.5%) during Feb. 14-20. Relative humidity influenced 72.73% powdery

Table 1 : Effect of weather parameters on percent disease index of powdery mildew.
Pant Vegetable Pea

Wk No.	SMW	Period	Age of the crop (day)	Temperature (^{0}C)		R.H. (%)		Wind velocity (Kmph)	PDI (%)	PDI Increase
				Max	Min	M	E		Pant vegetable pea	Pant vegetable pea
1	45	Nov 05-11	1-7	30.0	16.7	91	37	0.6	0	0
2	46	12-18	8-14	27.5	13.2	91	36	1.0	0	0
3	47	19-25	15-21	30.0	16.7	87	40	1.5	0	0
4	48	26-02	22-28	30.0	15.6	83	35	1.6	0	0
5	49	Des 03-09	29-35	28.1	11.8	91	31	1.3	1.2	1.2
6	50	10-16	36-42	27.7	9.8	90	27	1.3	5.4	4.2
7	51	17-23	43-49	28.1	11.7	90	34	1.6	19.75	14.35
8	52	24-31	50-56	28.3	12.7	93	40	0.9	32.12	12.37
9	1	Jan01-07	57-63	28.6	13.6	90	40	0.7	34.37	2.25
10	2	08-14	64-70	27.8	14.1	90	47	1.6	52.62	18.25
11	3	15-21	71-77	29.0	16.1	89	46	2.5	70.62	18
12	4	22-28	78-84	28.2	13.7	87	38	2.3	82.25	11.63
13	5	29-04	85-91	28.8	10.1	86	28	2.0	94	11.75

SMW- Standard meteorological week, PDI – Percent disease index, Temperature Max Maximum temperature, Temperature Min - Minimum temperature, R.H. M – Relative humidity morning and R.H. E - Relative humidity evening.

Table 2 : Correlation between PDI of pea powdery mildew in relation to weather parameters.
Pant Vegetable Pea

S. no.	Weather parameters	Correlation coefficient (r)
1.	Maximum temperature (^{0}C)	-0.17
2.	Minimum temperature (^{0}C)	-0.19
3.	Relative humidity during morning (%)	-0.21
4.	Relative humidity during evening (%)	0.22
5.	Wind Velocity (Kmph)	0.67

* Significant at 5% (r value- 0.53) and ** Significant both at 5% and 1% (r value- 0.66)

mildew development on pea and remaining 27.27% were unexplained climatic variations.

During the cropping period maximum temperature ranges from 27.5^{0}C to 30.0^{0}C, minimum temperature from 9.8^{0}C to 16.7^{0}C, relative humidity during morning ranged from 83% to 93% relative humidity during evening ranged from 27% (50th SMW 2013) to 47% (2nd SMW 2014). And increase in PDI was maximum in temperature ranges from 27.8-28.1^{0}C (maximum) and 11.7-14.1^{0}C (minimum) temperature, wind velocity (Kmph) 1.6 and average 66% relative humidity.

Correlation study

To develop a relationship of PDI with weather variables, the relationship indicated significant negative and positive correlation of disease with factors namely; maximum temperature (-0.17), minimum temperature (-0.19), RH morning (-0.21), RH evening (0.22) and Wind velocity (0.67). Correlated PDI with weather parameters and reported significant negative and positive correlation among weather. The correlation coefficient (r) between powdery mildew Severity and weather parameters indicated that disease Severity in this varieties was negatively correlated with Maximum and minimum temperature. Mildew severity in relation to relative humidity during Morning negatively and evening was positively correlated and the correlation of Powdery mildews severity with the speed of wind is significant positively correlated.

During the cropping period, maximum temperature ranges from 27.5^{0}C to 30.0^{0}C, minimum temperature from 9.8^{0}C to 16.7^{0}C, relative humidity during morning ranged from 83% to 93% relative humidity during evening ranged from 27% (50th SMW 2013) to 47% (2nd SMW 2014). And increase in PDI was maximum in temperature ranges from 27.8-28.1^{0}C (maximum) and 11.7-14.1^{0}C (minimum) temperature, wind velocity (Kmph) 1.6 and average 66% relative humidity.

Correlation study

To develop a relationship of PDI with weather variables, the relationship indicated significant negative and positive correlation of disease with factors namely; maximum temperature (-0.19), minimum temperature

Table 3 : Effect of weather parameters on per cent disease index of Powdery mildew.
Azad-P-3

Wk No.	SMW	Period	Age of the crop (day)	Temperature (^{0}C)		R.H. (%)		Wind velocity (Kmph)	PDI (%)	PDI Increase
				Max	Min	M	E		Azad-P-3	Azad-P-3
1	45	Nov 05-11	1-7	30.0	16.7	91	37	0.6	0	0
2	46	12-18	8-14	27.5	13.2	91	36	1.0	0	0
3	47	19-25	15-21	30.0	16.7	87	40	1.5	0	0
4	48	26-02	22-28	30.0	15.6	83	35	1.6	0	0
5	49	Des 03-09	29-35	28.1	11.8	91	31	1.3	3.7	3.7
6	50	10-16	36-42	27.7	9.8	90	27	1.3	13	9.3
7	51	17-23	43-49	28.1	11.7	90	34	1.6	16	3
8	52	24-31	50-56	28.3	12.7	93	40	0.9	20.25	4.25
9	1	Jan01-07	57-63	28.6	13.6	90	40	0.7	26.62	6.37
10	2	08-14	64-70	27.8	14.1	90	47	1.6	50.62	24
11	3	15-21	71-77	29.0	16.1	89	46	2.5	66.62	16
12	4	22-28	78-84	28.2	13.7	87	38	2.3	83.5	16.88
13	5	29-04	85-91	28.8	10.1	86	28	2.0	90	6.5

Table 4 : Correlation between PDI of pea powdery mildew in relation to weather parameters.
Azad-P-3

S. no.	Weather parameters	Correlation coefficient (r)
1.	Maximum temperature (^{0}C)	-0.19
2.	Minimum temperature (^{0}C)	-0.21
3.	Relative humidity during morning (%)	-0.26
4.	Relative humidity during evening (%)	0.16
5.	Wind Velocity (Kmph)	0.72

*Significant at 5% (r value- 0.53) and **Significant both at 5% and 1% (r value- 0.66)

(-0.21), RH morning (-0.26), RH evening (0.16) and Wind Velocity (0.72). Correlated PDI with weather parameters and reported significant negative and positive correlation among weather. The correlation coefficient (r) between powdery mildew Severity and weather parameters indicated that disease Severity in this varieties was negatively correlated with Maximum and minimum temperature. Mildew severity in relation to relative humidity during Morning negatively and evening was positively correlated and the correlation of Powdery mildews severity with the speed of wind is positively significant correlated. Thakur and Agarwal (1995) was reported positive correlation between same parameter.

References

Anonymous (2013). *Area and Production of Horticultural crops in Chhattisgarh*. Director Horticulture Chhattisgarh, Raipur.

Anonymous (2013). *Indian Horticulture Data base*. National Horticulture Board, Department of Agriculture Cooperation, Ministry of Agriculture.

Ali, M., S. K. Jain, M. Lal, M. Zuhaib, S. Kumar and S. Srivastva (2014). Survey, media requirement and management of fusarium wilt of pea. *The Bioscan*, **9(3)** : 1213-1216.

Banyal, D. K. and P. D. Tyagi (1998). Development of powdery mildew of pea in relation to different climatic condition in Himachal Pradesh. *Pl. Dis. Res*., **13(2)** : 154-156.

Choudhury, R. P., H. Tanveer and G. P. Dixit (2006). Identification and detection of genetic relatedness among important varieties of pea (*Pisum sativum* L.) grown in India. *Genetica*, **130** : 183-191.

Dixon, G. R. (1987). Powdery mildew of vegetables and allied crops. In : *The powdery mildew*. D.M. Spencer (Ed.). Acad. Press, p. 565.

Guzman Plazola, R. A., R. M. Davis and J. J. Marois (2003). Effects of relative humidity and high temperature on spore germination and development of tomato powdery mildew (*Leveillula taurica*). *Crop Protection*, **22** : 1157-1168.

Kachhot, P., R. Shah, B. L. Mali and H. K. Jain (2011). Mildew of pea (*Pisum savitum* L.) caused by *Erysiphe pisi* DC. *J. Pl. Dis. Sci.*, **6(1)** : 39-43.

Kumar, A. and S. K. Gupta (2006). Influence of abiotic environmental factors on pea powdery mildew. *J. Mycol. Pl. Path.*, **36(2)** : 182-184.

Munjal, R. L., V. V. Chenulu and T. S. Hora (1963). Assessment of losses due to powdery mildew (*Erysiphe polygon* DC) on pea. *Indian Phytopath*., **16(1)** : 268-270.

Nisar, M., A. Ghafoor, M. R. Khan and A. S. Qureshi (2006). Screening of *Pisum sativum* L. Germplasm against *Erysiphe pisi* Syd. *Acta Biologica Cracoviensia Series Botanica*, **48(2)** : 33-37.

Paul, Y. S. and R. P. Kaushal (1985). Effect of relative humidity on germination of powdery mildew conidia. *Indian Phytopath*., **38(4)** : 757-758.

Saxena, D. R. and Moly (1993). Epidemiology of powdery mildew of mungbean. *Indian J. Pulses Res*., **4(1)** : 65-67.

Saxesena, R. R., V. Vidyakar, M. K. Vishwakarma, P. S. Yadav, M. L. Meena and G. M. Lal (2014). Genetic variability and heritability analysis for some quantitative traits in field pea (*Pisum sativum* L). *The Bioscan*, **9(2)** : 895-898.

Schnathorst, W. C. (1959). Spread and life cycle of the letture powdery mildew fungus. *Phytopath*., **49** : 64-68.

Sharma, A. K. (1992). Effect of planting dates and weather on powdery mildew of pea. *Indian J. Mycol. Pl. Path*., **22(3)** : 291-293.

Sharma, S. (2003). Relationship of rainfall with powdery mildew (*Oidium erysiphoides* f.sp. *ziziphi*) of jujube (*Ziziphys mauritiana*).

Singh, U. P. (2000). Pea-Powdery mildew an ideal pathosystem. *Ind. Phytopathol*., **53** : 1-9.

Thakur, M. P. and K. C. Agrawal (1995). Epidemiological studies on powdery mildew of mungbean and urdbean. *Int. J. Pest Management*, **41** : 146-153.

Vander Plank, J. E. (1963). *Plant disease, Epidemics and control.* Academic Press, New York, p. 349.