Effect of weather variables on the development of Lentil wilt caused by *Fusarium oxysporum*f.sp. *lentis.*

Abstract

Wilt of lentil, caused by *Fusarium oxysporum*f.sp. *lentis*is a severdisease caused by *Fusarium oxysporum*f.sp. *lentis* and significantly reduce lentil yield in India and the world. The present studies were undertaken to study the effect of weather variables on disease development. The crop was sown on four dates during rabi 2019-20 and 2020-21. The dates of sowing were 15th October, 30th October, 15th November, and 30th November during both years. Results revealed that temperature was positively correlated, and relative humidity was negatively correlated with the disease incidence.

Key words: Lentil, Lentil wilt, *Fusarium oxysporum*f.sp. *lentis.*

1. Introduction

Pulses are essential to human food, and pulses are very rich in protein content and quality. The protein content ranges from 17-24 percent in pulses, 2-3 times more than in cereals. Pulses play an important role in our country's food and farming economy. (Garkoti et. al., 2013). Lentil (Lens culinaris Medikus), considered the oldest pulse crop, may have been domesticated up to 13,000 BC in habitation. It is mainly grown in India, Egypt, Greece, Bangladesh, Pakistan, Italy, countries in the Mediterranean region, and North America. Lentil is a highly proteinaceous crop as it contains 25 percent protein and is suitable for cultivation under varied climatic conditions. It improves the soil fertility in the areas where other legumes are not grown. Lentil provides affordable protein; hence, it is also known as poor man's meat [7,8]. Fusarium wilt caused by Fusarium oxysporum f. sp. lentis is predominant in the lentil-growing areas worldwide, mainly India, Pakistan, Greece, Canada, Bangladesh, Syria, Italy, and countries in the North American Mediterranean region. The pathogen is soil and seed-borne [9,10,11]. It colonizes and completely blocks the xylem vessels, leading to the wilting of plants. The disease can occur at any stage of the crop, starting from the seedling stage. However, the yield losses depend upon the stage at which the plant wilts. Epidemiology and temporal factors also affect the disease incidence. Hence, the current study examined the incidence of wilt on lentils.

2. Materials and Methods

2.1 Isolation and identification of pathogen

The roots of the samples were washed in running water to remove the soil. The pathogen was isolated from the root and stem of the plant and maintained on a potato dextrose agar medium. Under laminar air flow, small 5mm bits were cut from the intermittent zone of healthy and diseased tissue. They were surface sterilized with 0.1% mercuric chloride for 15-20 seconds and subsequently washed in sterilized distilled water 3-4 times. Excessive moisture was removed by keeping the sterilized bits on sterilized blotting paper under aseptic conditions, which were then transferred to PDA slants using a sterilized inoculation needle. These test tubes were incubated at 28℃ for one week. All the precautions were taken to prevent contamination. The isolate's pure culture was obtained using the single spore method. The diluted mycelial suspension was spread uniformly on 2 percent water agar plates. A single spore was marked and allowed to grow. The single spore was then cut and transferred to the PDA slants under aseptic conditions with the help of an inoculation needle and incubated at a temperature of 28±1°C for four days. Later, the mycelial bits of the fungus were placed in the center of Petri plates containing potato dextrose agar medium and incubated at 28±1°C.2.2 Effect of weather variables on the development of disease

To study the effect of weather variables, i.e., temperature (maximum, minimum, and average), relative humidity (maximum, minimum, and average), and Rainfall (mm) on the development of disease, an experiment was conducted at the Research sub-station (RSS), Akrot (Una). During Rabi 2019-20 and 2020-21. The crop was sown on four different dates, i.e., 15th October, 30th October, 15th November, and 30th November, and data on disease incidence were recorded weekly. Data on weather variables (temperature, relative humidity, and Rainfall) were collected from the Meteorological Centre, IMD, Bibra House, Cliffend Estate, and Shimla (HP).

The correlation between disease incidence (%) and weather variables was calculated, and regression equations were derived. The relationship between disease incidence and various weather variables for disease development was determined by studying simple, partial, and multiple correlations. Regression coefficients were calculated, and regression equations were formed. From the data on disease incidence, further AUDPC and infection rate (r) were calculated using respective formulas.

The AUDPC was calculated using the formula given by Shaner and Finney (1977).

$$AUDPC = \sum (y_i + y_{i+1}) / 2 \times (t_{i+1} - t_i)$$

Where y_i = Disease incidence at time t_i

y_{i+1} = Disease incidence at time t_{i+1}

Expected disease incidence was also calculated from the regression equation developed and compared with observed disease incidence for testing the fitness of the calculated regression equation.

3.Results and Discussion

An experiment was conducted at RSS, Akron, to study the effect of the weather variables (temperature, relative humidity, and precipitation) on the development of lentil wilt. The lentil variety HPL-5 was sown on the 15th and 30th of October and the 15th and 30th of November during rabi 2019-2020 and 2020-21 under field conditions. The data on disease incidence (%), temperature (°C), relative humidity (%), and precipitation (mm) were recorded at weekly intervals and are presented in Table 1. The data revealed that disease incidence during Rabi 2019-20 was higher on the crop sown on 15th October (9.67%) in comparison to 30th October (5.43%), 15th November (2.72%), and 30th November (1.95%). A similar trend was followed in rabi 2020-21 as the disease incidence was recorded more on 15th October (9.46%), followed by 30th October (5.74%), 15th November (2.61%), and 30th November (1. 61%). Ghatak et al. (2014) reported that increased inoculum resulted in a higher incidence of several; however, increased inoculum proved ineffective under cooler conditions. Early sowing associated with high soil temperature (22.6°C) resulted in maximum wilt incidence (97.2%). Under laboratory conditions, maximum radial growth of the fungus was recorded at higher temperatures (27°C). Data on disease incidence of four dates of sowing were correlated with temperature (maximum, minimum, and average), relative humidity (maximum, minimum, and average), and precipitation, and the correlation coefficient and regression equations were calculated and presented in Table 1.

Conclusion

It is concluded that the disease can occur at any stage of the crop, starting from the seedling stage. However, the yield losses depend upon the stage at which the plant wilts. Epidemiology and temporal factors also affect the disease incidence.

Table 1.Effect of weather variables on disease development during 2019-2020 and 2020-21.

a. Simple correlation coefficients between disease incidence and weather variables						
Date of sowing	Percent disease incidence	Simple correlation coefficients				
		DS× maxT	DS× minT	DS× maxRH	DS × min RH	DS× Precipitation
15th Oct.2019	9.67	0.920**	0.857**	-0.801**	-0.816**	0.147NS

30th Oct. 2019	5.43	0.813**	0.754**	-0.868**	-0.858**	0.326NS
15th Nov. 2019	2.72	0.682*	0.827**	-0.905**	-0.938**	0.364NS
30th Nov. 2019	1.95	0.702*	0.845**	-0.915**	-0.941**	0.392NS
15th Oct.2020	9.46	0.943**	0.823**	-0.932**	-0.764**	0.236NS
30th Oct. 2020	5.74	0.955**	0.855**	-0.869**	-0.576**	0.260NS
15th Nov. 2020	2.61	0.880**	0.976**	-0.896**	-0.543NS	0.178NS
30th Nov. 2020	1.61	0.836**	0.957**	-0.940**	-0.549NS	0.427NS

b. Partial correlation coefficients between disease incidence and weather variables						
Date of sowing	Percent disease incidence	Partial correlation coefficients				
		DS× maxT	DS× minT	DS× maxRH	DS× minRH	DS× Precipitation
15th Oct.2019	9.67	-0.604	-0.607	-0.184	-0.179	0.272
30th Oct. 2019	5.43	0.133	0.128	-0.046	-0.044	0.335
15th Nov. 2019	2.72	0.224	0.226	-0.393	-0.396	-0.017
30th Nov. 2019	1.95	0.049	0.051	-0.476	-0.477	0.222
15th Oct.2020	9.46	0.559	0.555	-0.723	-0.032	-0.096
30th Oct. 2020	5.74	0.829	-0.286	-0.498	0.527	-0.001
15th Nov. 2020	2.61	0.277	0.795	-0.230	0.202	0.014
30th Nov. 2020	1.61	-0.438	0.798	-0.868	0.702	-0.556

c. Regression equation between disease incidence and weather variables

Date of sowing	Percent disease incidence	Regression equation	Multiple correlation coefficient R	Coefficient of determination (R^2)
15th Oct.2019	9.67	Y=7.324+0.688(V1)-0.029(V2)-0.203(V3)+0.004(V4)+0.077(V5)	0.977	0.9546
30th Oct. 2019	5.43	Y=13.14+0.481(V1)-0.219(V2)-0.345(V3)+0.135(V4)+0.144(V5)	0.9634	0.9282
15th Nov. 2019	2.72	Y=11.64-0.024(V1)+0.255(V2)+ 0.134(V3)-0.434(V4)-0.06(V5)	0.9588	0.9192
30th Nov. 2019	1.95	Y=7.255+0.018(V1)+0.217(V2)+0.043 (V3)-0.229(V4)+0.021(V5)	0.9644	0.9301
15th Oct.2020	9.46	Y=33.84+0.455(V1)-0.250(V2)-0.466(V3)-0.010(V4)-0.025(V5)	0.983	0.967
30th Oct. 2020	5.74	Y=3.915+0.442(V1)-0.107(V2)-0.232(V3)+0.174(V4)+0.00(V5)	0.972	0.944
15th Nov. 2020	2.61	Y=1.002+0.073(V1)+0.397(V2)-0.080(V3)+0.049(V4)+0.003(V5)	0.980	0.960
30th Nov. 2020	1.61	Y=18.050-0.063(V1)+0.206(V2)-0.305(V3)+0.120(V4)-0.068(V5)	0.990	0.980

**Values significantly correlated maxT (V1) = Maximum temperature (℃) min T(V2) = Minimum temperature max RH (V3) = Maximum relative humidity min RH (V4) = Minimum relative humidity Precipitation (V5) DI (Y) = Per cent disease incidence (%)

REFERENCES

1. Cruz RD, Leandro FS Leonor and Munkvold PG. 2019. Effects of temperature and pH on *Fusarium oxysporum* and soybean seedling disease. Plant disease **103**: 3234-3243.
2. Garkoti A, Kumar S, Singh M and Singh V. 2013. Epidemiology and disease management-A Review. *AGRIWAYS***1**:62-64.
3. Ghatak A., Shukla N., Ansar M., Balodi R., and Kumar J. 2014. Effect of sowing time, soil temperature and inoculum density on suppression of *Fusarium* wilt in lentil

(Lens culinaris). International journal of Bio-resource and stress management. **6**: 268-273.

4. Patil M, Om G, Pawar M and Chobe DR. 2015. Effect of culture media, pH and temperature on the mycelial growth and sporulation of *Fusarium oxysporum*f.sp. *ciceris* isolates of chickpea from Central Zone of India. *JNKVV Research Journal***49**: 54-60.
5. Shaner, G. and Finney, R.E. 1977. The use of area under the disease progress curve (AUPDC) to assess quantitative disease resistance in the crop. *Theoretical and Applied Genetics*, **102**: 32-40.
6. Vasudeva RS and Srinivasan KV.1952. Studies on the wilt disease of lentil (*Lens esculenta* Moench.). *Indian Phytopathology***5**:23-32.
7. Fatima K, Khan MA, Raza MM, Yaseen M, Iqbal MA, Shahbaz MU. Identification of resistant source in lentil germplasm against Fusarium wilt in relation to environmental factors. Academic Research Journal of Agricultural Science and Research. 2015;3:60-70.
8. Ali Y, Qin A, Aatif HM, Ijaz M, Khan AA, Ahmad S, Shahzad U, Yasin M, Rahman SU. A stepwise multiple regression model to predict Fusarium wilt in lentil. Meteorological Applications. 2022 Jul;29(4):e2088.
9. Das T, Sandham T, Umbrey Y, Mahapatra S, Das S. An overview of fusarium wilt of lentil status in different Districts of West Bengal, India. InBiological Forum-An International Journal 2022 (Vol. 14, No. 2, pp. 974-978).
10. Desai S, Prasad RD, Kumar GP. Fusarium wilts of chickpea, pigeon pea and lentil and their management. Microbial Interventions in Agriculture and Environment: Volume 3: Soil and Crop Health Management. 2019:49-68.
11. Parihar AK, Basandrai AK, Saxena DR, Kushwaha KP, Chandra S, Sharma K, Singha KD, Singh D, Lal HC, Gupta S. Biplot evaluation of test environments and identification of lentil genotypes with durable resistance to fusarium wilt in India. Crop and Pasture Science. 2017 Sep 27;68(11):1024-30.