

Effect of weather variables on the development of Lentil wilt caused by *Fusariumoxysporumf.sp.lentis*.

Comment [m1]: Not specific

Comment [m2]: Not specific

Abstract

Wilt of lentil, caused by *Fusariumoxysporumf.sp. lentis* is a serious disease caused by *Fusariumoxysporumf.sp. lentis* and which plays a major role in reducing lentil yield in India and the world. These present studies were undertaken to study on the effect of weather variables on the development of the disease development. The crop was sown on four dates during rabi 2019-2020 and 2020-2021. The sowing dates of sowing were 15th October, 30th October, 15th November and 30th November during both the years. Results revealed that temperature was positively correlated with the disease incidence but relative humidity was negatively correlated and with the disease incidence.

Comment [m3]: What is rabi. rephrase

Comment [m4]: Not clear. Which T, RH

Keywords: Lentil, Lentil wilt, *Fusariumoxysporumf.sp. lentis*.

1. Introduction

Pulses constitute an important part of human food and pulses are very rich in protein content and quality. The protein content ranges from 17-24% percent in pulses which is 2-3 times more than in cereals. Pulses play an important role in the food and farming economy of our country (Garkotiet. al., 2013). Lentil (*Lens culinaris* Medikus) is considered as the oldest pulse crop, maybe domesticated in up habitation to 13,000 years BC.

Lentil is mainly grown in India, Egypt, Greece, Bangladesh, Pakistan, Italy, countries in the Mediterranean region and North America. Lentil is highly proteinaceous crop as it contains 25 per cent of 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.

Fusarium wilt caused by *Fusariumoxysporum f. sp. lentis* is predominant in the lentil growing areas worldwide, mainly India, Pakistan, Greece, Canada, Bangladesh, Syria, Italy, countries in the North America Mediterranean region. The pathogen is soil and seed borne. It colonizes and completely blocks the xylem vessels leading to wilting of plant. The disease can occur at any stage of the crop starting from seedling stage however, the yield losses depends upon the stage at which the plant wilts. Epidemiology and temporal factors also affects the disease incidence. Hence the current study was conducted to examine the incidence of wilt on lentil.

Comment [m5]: You have not justified why this work was carried out. You have failed to demonstrate any knowledge of the current state of research on lentil wilt. No references. No serious pathology related problem statement?

Comment [m6]: Is this the objective? It is very poorly worded. redo

Comment [m7]: It seems you had two trials – lab and field – separate them and be concise, precise and laconic in presenting these procedures herein

2. Materials and Methods

2.1 Isolation and identification of pathogen

The roots of 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 potato dextrose agar medium. Under laminar air flow, small 5mm bits were cut from the intermittent zone of healthy and diseased tissue and were surface sterilized with 0.1% of mercuric chloride for 15-20 seconds and subsequently washed in sterilized distilled water for 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 sterilized inoculation needle. These test tubes were incubated at 28°C for one week. All the precautions were taken to prevent contamination. The pure culture of the isolate was obtained by using single spore method. The diluted mycelial suspension was spread uniformly on 2% per cent water agar plates. 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 inoculation needle and incubated at temperature of 28±1°C for 4 days, later the mycelial bits of the fungus were placed in the centre 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 Research sub-station (RSS), Akrot (Una). During the 2019-20 and 2020-21. Crop was sown on at 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 obtained collected from the Meteorological centre, IMD, Bibra House, Cliffend Estate, Shimla (HP).

Correlation between disease incidence (%) and weather variables were 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 by using respective formulas.

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

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

Comment [m8]: how

Comment [m9]: Which???

Comment [m10]: ?????

Comment [m11]: Which, when???

Comment [m12]: Explain with references how, why, etc

Comment [m13]: Educate us. How did you mark it

Comment [m14]: How did you cut a single spore

Comment [m15]: ????

Comment [m16]: Explain in scientific manner what you are up to

Comment [m17]: How did you arrive at precipitation used for calculations. This is not ok

Comment [m18]: how

Comment [m19]: where are they

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

3. Results and Discussion

To study the effect of the weather variables (temperature, relative humidity and precipitation) on the development of lentil wilt, an experiment was conducted at RSS, Akrot. The lentil variety HPL 5 was sown on 15th, 30th October and 15th, 30th November during rabi 2019-2020 and 2020-21 under field conditions. The data on disease incidence (%), temperature (°C), relative humidity (%) and precipitation (mm) recorded at weekly interval and are presented in table 1 and figure 1. The data revealed that disease incidence during Rabi 2019-20 was more 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%). 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 amount of inoculum resulted in higher incidence of number of however, increased inoculum proved to be ineffective under cooler condition. 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 temperature (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.

Comment [m20]: How was it calculated???

Comment [m21]: Separate the results in to two groups. Field and laboratory

Comment [m22]:

Comment [m23]: No discussion of any sort was presented

Comment [m24]: Why are you presenting data

Comment [m25]: Incomplete

Comment [m26]: How did you maintain this temperature???

Comment [m27]: Not clear, not scientific. How did you maintain temperatures at min, max and average? State and explain how the precipitation was kept constant???. Same for relative humidity

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

a. Simple correlation coefficients between disease incidence and weather variables		
Date of sowing	Percent disease	Simple correlation coefficients

	incidence	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

Comment [m28]: What is precipitation exactly

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

Comment [m29]: ??? who did you arrive at this lone figure

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

Comment [m30]: How did you arrive at one figure, etc

**Values significantly correlated maxT (V1) = Maximum temperature (°C) 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 (%)

Comment [m31]: Not clear

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Comment [m32]: 5 references are not enough. Minimum of 20 will do

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