



Assessment on the Prevalence of Wilt of Lentil in Different Districts of Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A comprehensive field survey was carried out to evaluate the incidence of wilt of lentil during the *rabi* seasons of 2018-19 and 2019-20 across various farmer's fields in different districts of western Uttar Pradesh. The pooled data of two years (2018-19 and 2019-20) revealed a significant variation in wilt incidence among the surveyed districts. The disease incidence ranged from 9.37 to 38.47 per cent with an overall average of 23.74%. The disease was present in each village across the ten districts surveyed, but significantly maximum disease incidence (38.47%) was recorded in Aligarh followed by Bulandshahr (34.83%), whereas, minimum per cent incidence was observed in district Muzaffarnagar (9.37%) followed by Saharanpur (11.86%). This variation highlights the need for region-specific management strategies to reduce the spread of lentil wilt.

Keywords: Wilt; lentil; survey; disease incidence; Uttar Pradesh.

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1. INTRODUCTION

Lentil (*Lens culinaris* Medik.) is an important pulse crop next to chickpea recognized for its high nutritional value. It is cultivated in subtropical and warm temperate regions and at high altitudes in the tropics. It is particularly well-suited for rainfed conditions and capable of standing in drought conditions. Its seeds contain carbohydrates (55.3%), protein (28.3%), fiber (8.5%), ash (5.3%), total lipids (2.1%), and various minerals like potassium, phosphorus, iron, and zinc [1]. It also facilitates atmospheric nitrogen fixation, and the ability to confiscate carbon ensures enriched nutrient status and soil fertility which aids in sustainable production [2]. Globally it is cultivated on an area of 5.53 mha with production and productivity of 6.65 mt and 1209.4 kg/ha, respectively (FAOSTAT, 2022). In India, this crop is grown on an area of 1.42 mha with a production of 1.28 mt annually and an average yield of 904 kg/ha (Agricultural Statistic at a Glance, 2022). While as, Uttar Pradesh ranks first in the area (0.49 mha) and production (0.47 mt) with an average productivity of 944 kg/ha (Agricultural Statistic at a Glance, 2022).

India reports over ten important diseases affecting lentil crops, which not only reduce yield but also degrade seed quality. Among them, Fusarium wilt caused by *Fusarium oxysporum* f. sp. *lentis* is one of the most destructive disease, which significantly impact lentil production and productivity by reducing crop stand in the field. This disease has been reported in major lentil-growing regions worldwide. The disease was first reported in Hungary Fleischmann, [3] and subsequently reported in many other countries including India [4]. In India, Fusarium wilt hampers lentil production in states such as Uttar Pradesh, Madhya Pradesh, Himachal Pradesh, Bihar, Rajasthan, Haryana, West Bengal, Assam, and Punjab [5].

The disease manifests at two growth stages of the crop i.e., the seedling stage (early wilt) or the reproductive stage (late wilt) [6,7]. Symptoms include stunting, epinasty, chlorosis, necrosis, significant reduction of the root system, internal vascular discoloration of the lower stem, shedding, and wilting [8,9]. It often occurs with other root rot pathogens like *Rhizoctonia solani*, *R. bataticola*, *S. rolfsii*, etc., forming a complex that leads to substantial loss of lentil seedlings. Various researchers have reported wilt incidence ranging from 50-78% in different fields [10,11].

The disease can cause 5-10% yield loss in India and may lead to complete crop failure under favourable conditions [12,2]. Ahmad [13] noted that the extent of yield loss due to this disease depends on the crop variety, growth stage, and prevailing environmental conditions. In a survey, Sharma et al. [14] also observed that none of the surveyed locations was found free from the incidence of lentil wilt in Madhya Pradesh.

The review of this disease impelled the present study to examine and appraise the incidence of lentil wilt in the ten districts of western Uttar Pradesh. This study has compiled comprehensive information on disease incidence, which will aid in developing effective management solutions for this devastating pathogen and alerting the farmers about the imminent risk to their crops.

2. MATERIALS AND METHODS

To assess the prevalence of wilt disease in lentil, a comprehensive field survey was conducted during the *rabi* seasons (2018-19 and 2019-20) at farmer's fields in ten districts of western Uttar Pradesh (Table 1, Fig 1). The observation was made from December to February of each cropping season, spanning from the pre-flowering to pod formation/maturity stage. A total of two hundred fifty diverse fields were monitored across the identified districts. Surveys were conducted in five villages per district, with five fields per village. In each farmer's field, a 1m x 1m area was marked at five selected spots for observation.

Plants exhibiting distinct symptoms of the wilt were taken into consideration. These disease samples were collected and brought to the laboratory for detailed analysis. Additionally, soil texture was also recorded in identified districts.

2.1 Data Recordings

$$\text{Disease incidence (\%)} = \frac{\text{Total number of infected plants}}{\text{Total number of plants}} \times 100$$

2.2 Statistical Analysis

The table data were presented in mean values of five replications of each treatment using MS Excel 2021. The data on the disease incidence (%) were analysed through single-factor ANOVA. The single-factor ANOVA to disease incidence (%) was evaluated in terms of Fischer's least

significant difference (LSD) and standard error of the mean (SEM) at the probability level $P \leq 0.05$. The statistical significance between the

treatments was determined by the Tukey HSD test at the probability level, $P \leq 0.05$, using R software [15].

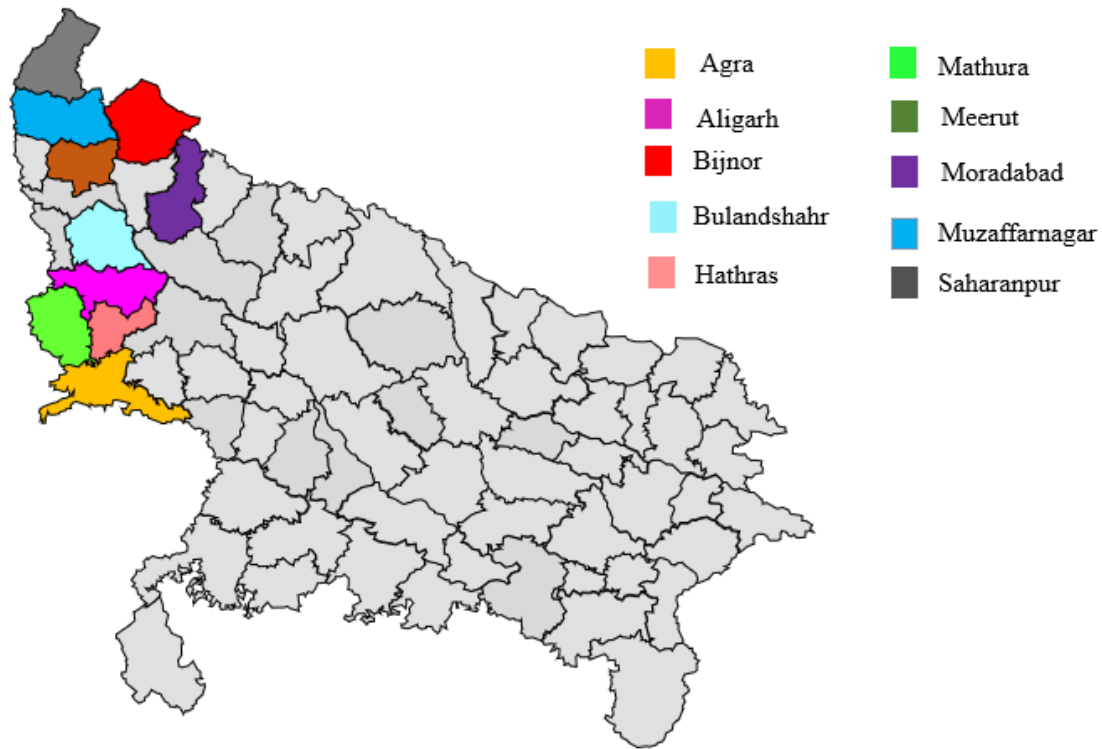


Fig. 1. Map showing different districts of Uttar Pradesh surveyed for lentil wilt prevalence

Table 1. Incidence of wilt on lentil in different villages of ten districts of Uttar Pradesh during rabi seasons of 2018-19 and 2019-20

Districts	Villages	Coordinates		Soil texture	Disease incidence (%)		
		Longitude (E)	Latitude (N)		2018-19	2019-20	Mean
Agra	Hazipur Khera	77°59'58.7	27°18'25.3	Sandy soil	36.20 ^{abc}	35.96 ^{a-f}	36.08
	Malupur	78°01'35.5	27°17'55.5	Sandy soil	28.11 ^{a-j}	32.13 ^{b-f}	30.12
	Nekpur	78°02'37.4	27°17'30.5	Sandy soil	34.45 ^{a-e}	37.50 ^{a-e}	35.97
	Poiya	78°02'29.8	27°16'17.1	Sandy soil	30.57 ^{a-h}	33.08 ^{a-f}	31.82
	Ujrai	78°01'58.9	27°17'25.0	Sandy soil	26.61 ^{a-k}	29.98 ^{b-g}	28.29
	Mean				31.18	33.73	32.45
Aligarh	Alampur Subkara	78°03'13.8	27°56'29.6	Sandy soil	39.23 ^{ab}	39.54 ^{ab}	39.38
	Asgarabad	78°14'07.6	28°04'17.2	Sandy soil	35.54 ^{a-d}	38.07 ^{a-d}	36.80
	Barhauili	78°14'23.5	28°04'12.7	Sandy soil	40.33 ^a	45.59 ^a	42.96
	Siya Khas	78°03'33.6	27°57'59.0	Sandy soil	38.15 ^{ab}	39.13 ^{abc}	38.64
	Tejpur	78°07'44.7	28°03'15.9	Sandy soil	31.50 ^{a-g}	37.66 ^{a-e}	34.58
	Mean				36.95	39.99	38.45
Bijnor	Abdipur Kishna	78°23'52.0	29°25'58.9	Clayey loam	18.72 ^{f-o}	17.05 ^{h-p}	17.88
	Inampur	78°25'15.4	29°26'36.0	Clayey loam	13.88 ^{f-o}	14.81 ^{h-p}	14.34
	Jalapur Bhunga	78°24'18.7	29°26'29.9	Clayey loam	12.70 ^{k-o}	11.72 ^{q-p}	12.21
	Malakpur Abdulla	78°24'52.3	29°27'12.5	Clayey loam	20.64 ^{e-o}	18.60 ^{q-p}	19.62
	Mean				16.49	15.54	16.01

Districts	Villages	Coordinates		Soil texture	Disease incidence (%)		
		Longitude (E)	Latitude (N)		2018-19	2019-20	Mean
	Palri	78°23'50.5	29°26'09.5	Clayey loam	09.92 ^{no}	07.64 ^p	08.78
	Mean				15.17	13.96	14.56
Bulandshahr	Akbapur	77°49'01.1	28°25'25.8	Loamy soil	36.12 ^{abc}	37.34 ^{a-e}	36.73
	Bahalimpur	77°50'53.5	28°22'42.8	Loamy soil	27.87 ^{a-j}	29.57 ^{b-h}	28.72
	Dhamrawali	77°50'17.3	28°22'42.8	Loamy soil	37.39 ^{ab}	34.91 ^{a-f}	36.33
	Pandrawal	78°11'43.7	28°07'03.3	Loamy soil	38.69 ^{ab}	39.61 ^{ab}	39.14
	Viraura	78°12'31.4	28°06'33.1	Loamy soil	32.57 ^{a-f}	34.32 ^{a-f}	33.44
	Mean				34.52	35.15	34.83
Hathras	Ajroi	78°04'53.7	27°40'51.3	Loamy soil	18.21 ^{f-o}	11.09 ^{op}	14.65
	Bijahari	78°04'33.8	27°41'21.1	Loamy soil	24.88 ^{b-m}	24.90 ^{e-n}	24.89
	Bilkhaura Khund	78°05'11.7	27°44'07.0	Loamy soil	21.50 ^{c-o}	17.64 ^{g-p}	19.57
	Jagipur	78°04'18.9	27°38'52.1	Loamy soil	13.69 ^{f-o}	9.81 ^p	11.75
	Ruheri	78°03'35.1	27°38'15.8	Loamy soil	15.93 ^{h-o}	16.45 ^{i-p}	16.19
	Mean				18.84	15.97	17.40
Mathura	Birbal	77°50'57.3	27°34'41.8	Loamy soil	20.67 ^{d-o}	26.36 ^{c-m}	23.51
	Birhana	77°49'52.8	27°34'11.3	Loamy soil	24.34 ^{b-n}	28.71 ^{b-i}	26.52
	Pirsua	77°49'13.1	27°33'53.4	Loamy soil	32.38 ^{a-g}	35.16 ^{a-f}	33.77
	Shivli	77°50'14.7	27°34'22.5	Loamy soil	28.00 ^{a-j}	32.41 ^{b-f}	30.20
	Tirwaya	77°48'07.1	27°33'32.4	Loamy soil	35.42 ^{a-e}	38.38 ^{a-d}	36.90
	Mean				28.16	32.20	30.18
Meerut	Allipur	77°45'28.8	28°54'04.8	Loamy soil	25.94 ^{a-l}	27.61 ^{b-j}	26.77
	Jijmana						
	Gagaul	77°42'52.5	28°53'54.6	Loamy soil	17.95 ^{f-o}	16.51 ^{i-p}	17.23
	Mamepur	77°44'14.0	29°01'38.3	Loamy soil	14.19 ^o	12.05 ^{nop}	13.12
	Naipur	77°45'10.4	28°48'50.9	Loamy soil	20.60 ^{e-o}	25.84 ^{d-m}	23.22
	Pepli Khera	77°45'31.5	28°52'52.4	Loamy soil	28.82 ^{a-i}	33.58 ^{a-f}	31.20
Mean				21.50	23.11	22.30	
Moradabad	Didaura	78°39'16.0	28°59'45.2	Loamy soil	21.42 ^{c-o}	23.27 ^{f-o}	22.34
	Bhainsla	78°42'52.4	28°50'47.0	Loamy soil	17.53 ^{g-o}	14.20 ^p	15.86
	Kasampur	78°37'51.2	29°04'10.1	Loamy soil	31.37 ^{a-g}	27.35 ^{b-k}	29.36
	Ladawali	78°41'57.8	28°56'20.6	Loamy soil	25.46 ^{a-l}	26.78 ^{b-l}	26.11
	Salawa	78°41'32.0	28°57'17.5	Loamy soil	36.18 ^{abc}	36.87 ^{a-e}	36.52
	Mean				26.39	25.69	26.04
Muzaffarnagar	Baghra	77°34'16.5	29°28'20.7	Clayey loam	10.08 ^{mno}	15.26 ^p	12.67
	Bahadapur	77°41'46.2	29°23'38.7	Clayey loam	07.51 ^o	07.34 ^p	07.41
	Bibipur	77°43'14.2	29°25'54.0	Clayey loam	08.32 ^o	09.37 ^p	08.84
	Sandhawali	77°42'36.5	29°25'23.2	Clayey loam	09.35 ^o	12.41 ^{nop}	10.91
	Wahalna	77°41'29.8	29°25'21.1	Clayey loam	07.26 ^o	06.84 ^p	07.05
	Mean				08.50	10.24	09.37
Saharanpur	Ghalauli	77°40'14.7	29°36'39.8	Clayey loam	14.74 ^{i-o}	17.30 ^{g-p}	16.02
	Gunarsa	77°40'28.0	29°38'56.0	Clayey loam	12.72 ^{k-o}	14.47 ^{k-p}	13.59
	Gunarsi	77°40'18.6	29°39'58.9	Clayey loam	08.31 ^o	07.56 ^p	07.93
	Isharapur	77°40'00.5	29°40'11.9	Clayey loam	09.41 ^o	09.45 ^p	09.43
	Jal Kheri	77°40'59.4	29°36'59.4	Clayey loam	11.19 ^{h-o}	13.56 ^{m-p}	12.37
	Mean				11.27	12.46	11.86
Grand mean					23.25	24.25	23.75
L.S.D.(P≤0.05)					7.06	6.12	-
SE(m)±					3.66	3.18	-

*Each value is an average of five replicates. Values followed by different alphabets within column are significantly different at P≤0.05 according to Tukey test.

3. RESULTS AND DISCUSSION

The incidence of wilt disease in lentil significantly varied in all ten districts of western Uttar Pradesh. In the surveyed districts, the

disease incidence ranged from 9.37 to 38.47 per cent with an overall average of 23.74%.

The disease was present in each village of ten districts; however, significantly maximum disease

incidence (38.47%) was recorded in district Aligarh followed by Bulandshahr (34.83%), thereby exhibiting significant differences from each other (Table 1). The minimum per cent incidence was observed in district Muzaffarnagar (9.37%) and it was found to be significantly at par with that recorded in Saharanpur (11.86%) and Bijnor (14.56%) (Table 1).

The pooled data of two years revealed a significant variation in incidence of wilt across different villages in the surveyed districts. The maximum incidence (42.96%) was recorded in village Barhauili of district Aligarh, and the minimum (7.05%) was in Wahalna village of district Muzaffarnagar (Table 1).

Regarding soil texture across the villages in the ten districts, it was found that soil of all surveyed field of different districts exhibited variation in their soil texture. Sandy soil texture was found in Agra and Aligarh; loamy soil was observed in Bulandshahr, Hathras, Mathura, Meerut and Moradabad. However, clayey loam texture was recorded in Bijnor, Muzaffarnagar and Saharanpur (Table 1). Maximum disease incidence (38.45%) was found in sandy texture of soil in Aligarh. Minimum incidence (9.37%) was observed in clayey loam soil of Muzaffarnagar district.

The present study clearly indicates that the prevalence of wilt in lentil varied significantly in ten different districts of western Uttar Pradesh during both survey years (2018-19 and 2019-20). Maximum incidence was recorded in Aligarh followed by Bulandshahr, Agra, Mathura and Moradabad. While, minimum incidence was noted in Muzaffarnagar. This trend was further supported with the record of maximum incidence of the disease in the village Barhauili of Aligarh and minimum in Wahalna village of Muzaffarnagar.

The similar results were also found by Prasad et al. (2021) during a survey conducted in different districts of Uttar Pradesh during the winter season of 2019-20 and 2020-21. They found the highest disease incidence at flowering (18.95%) and podding stages (14.27%) in Kanpur district for 2019-20, with the lowest incidence at flowering (11.50%) and podding (10.86%) in Ayodhya district. In 2020-21, the highest incidence at flowering was in Sitapur (15.18%), and at podding in Kanpur (15.75%), while the lowest was again in Ayodhya, at flowering (11.73%) and podding (9.86%).

In another study, Shrivastava and Dhakad [16] also reported the maximum average disease incidence in Sehore district (17.87%) and the minimum in Sagar district (13.07%) of Madhya Pradesh. The variation in wilt incidence across different locations may be attributed to factors such as varied agro-climatic conditions, cropping patterns, inappropriate cultural practices (e.g., close spacing, frequent irrigations, sowing dates, heavy fertilization), inoculum levels and common management practices affecting disease development. Additionally, the pathogen, which is both seed- and soil-borne, thrives in warm weather, acidic, and sandy soils, which may explain the higher wilt incidence in Aligarh. The survey also revealed that many fields were planted solely with lentil, which could increase pathogen populations and exacerbate the disease [17]. Favourable environmental conditions, soil texture, and the use of susceptible varieties also likely contributed to the increased incidence of the disease in these areas [18,19].



Plate 1. Field showing the infection of lentil wilt disease

4. CONCLUSION

The prevalence of wilt in lentil varied significantly across different locations in western Uttar Pradesh. Maximum incidence was observed in district Aligarh followed by Bulandshahr, Agra, Mathura, Moradabad, Meerut, Hathras, Bijnor, Saharanpur and Muzaffarnagar. The overall average per cent of incidence across the ten districts was observed maximum in 2019-20 (24.25%) compared to 2018-19 (23.24%). This variation could be attributed to the prevailing environmental conditions and incessant cultivation of susceptible varieties by the farmers in these locations over the years. The study emphasizes the need to identify new sources of resistance under field conditions and promote the use of resistant cultivars to combat this disease.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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