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Research Paper

Assessing the impact of weather variables on ascochyta blight development in chickpea

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ABSTRACT

A field survey was conducted to study the influence of weather parameters, disease incidence and severity of Ascochyta blight (*Ascochyta rabiei* Passerini) in chickpea. Epidemiological studies indicated that the Percent Disease Index (PDI) increased linearly with plant growth. Weather parameters such as minimum temperature, relative humidity and rainfall showed significant negative correlations with the development of these blight diseases. Multiple linear regression analysis revealed that the coefficient of multiple determination (R) was 0.94, suggesting that these weather factors accounted for up to 60% of the variation in disease. The regression equation indicated that a 1% increase in morning relative humidity resulted in a 0.446% increase in PDI disease. Conversely, a 1°C increase in minimum temperature led to a decrease in disease severity by 5.606% for the disease. These findings provide valuable insights for monitoring weather-driven disease progression and developing effective management strategies for controlling this disease.

Key words**:** Ascochyta blight, Chickpea, Correlation, Percent disease incidence, standard meteorological week, Weather

INTRODUCTION

Pulses represent a crucial component of Indian agriculture and serve as an affordable source of protein. Among these, chickpea (*Cicer arietinum* L.) is favoured over other food legumes due to its diverse applications globally. As a self-pollinating annual legume, chickpea ranks second in the world, following soybean, in terms of food legume crops (Varshney *et al*. 2013). It is primarily cultivated in arid and semi-arid regions across more than 50 countries, in Asia, Africa, Europe, Australia, North America and South America (Chandora *et al*. 2020). Globally, chickpea production reaches 17.2 mt from approximately 17.8 m ha, accounting for 15% of the total area dedicated to pulses (Gayacharan *et al.* 2020). In India, chickpea is cultivated over an area of 9.99 m ha, yielding 11.91 mt with a productivity rate of 1192 kg per hectare during the 2020–21 period. In Uttar Pradesh, which spans 6.11 lakh hectares, the production reached 7.59 lakh tons, with a productivity of 1243 kg per hectare in the same time frame (Anonymous 2021). The Bundelkhand region of Uttar Pradesh is historically significant for chickpea cultivation, covering 4,16,007 hectares and producing approximately 148,408 tons. In this area, chickpea plays a vital role in various cropping sequences and is predominantly grown under rainfed mono-cropping systems. However, challenges such as inadequate seed replacement, low productivity, high occurrences of pod borer and root diseases, along with various abiotic stresses, restrict the average productivity of chickpea in the region to 400 kg per hectare, compared to the national average of 1037 kg per hectare (Sah *et al*. 2021, Singh *et al*. 2022). The crop is known to be vulnerable to over a dozen well-documented pathogens (Nene and Reddy 1987, Cother 1977). Among these, Ascochyta blight (*Ascochyta rabiei* Pass.) is recognized as one of the most severe diseases affecting chickpea (Nene 1982), and the pathogen is also capable of infecting wild *Cicer* species (Collard *et al.* 2001). The disease has been documented in 34 countries spanning all six continents and is particularly prevalent in West Asia, Northern Africa, and Southern Europe (Nene and Reddy 1987, Kaiser *et al*. 2000, Pande *et al*. 2005, Labdi *et al*. 2013, Sun *et al*. 2016, Tadesse *et al.* 2017). Symptoms of Ascochyta blight manifest on all above-ground parts of the plant, including leaves, stems and pods. Infected areas exhibit necrotic lesions accompanied by small black structures known as pycnidia, which are arranged in concentric circles. Additionally, diseased plants may experience stem breakage, pod infection and girdling, leading to the collapse of twigs. Secondary infections are facilitated by airborne conidia present within the pycnidia (Reddy and Singh 1990). The disease can result in yield losses of up to 100% (Pande *et al.* 2005). *A. rabiei* can be grown on various media, with its growth rate differing depending on the medium used (Harveson *et al*. 2011). Although host plant resistance to ascochyta blight has recently improved in several chickpea genotypes, these plants still require fungicide treatment during the flowering and pod formation stages (Chongo and Gossen 2001). The resistance mechanisms in newly developed chickpea varieties are also compromised by *A. rabiei*, which continues to evolve (Chen *et al.* 2004, Gan *et al.* 2006, Kanouni *et al.* 2011). The application of fungicides such as chlorothalonil, trifloxystrobin 50% WG, sulfur, propiconazole and mancozeb has proven effective in managing ascochyta blight (Bashir and Ilyas 1983, Bashir *et al*. 1987, Nene and Reddy 1987, Demirci *et al.* 2003). Given the significance of chickpea and the associated disease, this study was conducted to assess the status of ascochyta blight in the Bundelkhand region of Uttar Pradesh, examine the cultural characteristics of the pathogen, and explore effective management strategies for crops in the field.

MATERIALS AND METHODS

A survey was conducted between January and February 2020-21 and 2021-2022 to assess the prevalence of ascochyta blight in the primary chickpea cultivation areas of the Banda, Hamirpur, Chitrakoot and Mahoba districts within the Bundelkhand region of Uttar Pradesh, India (Table 1).

Table 1. List of surveyed blocks for the occurrence of ascochyta blight

District	Block	Latitude/ Longitude
Hamirpur	Gohand	25.7159° N, 79.5210° E
	Rath	25.6021° N, 79.5660° E
	Muskara	25.6653° N, 79.7988° E
Banda	BadokharKhurd	25.3254° N, 80.3784° E
	Bisanda	25.4763° N, 80.3395° E
	Jaspura	25.8118° N, 80.3756° E
Chitrakoot	Ramnagar	29.3948° N, 79.1265° E
	Mau	25.9463° N, 83.5610° E
	Manikpur	25.0699° N, 81.1031° E
Mahoba	Jaitpur	25.2868° N, 79.5772° E
	Kabrai	25.3985° N, 80.0032° E
	Panwari	25.4287° N, 79.4732° E

Collection of weather data

The meteorological parameters, including temperature (Max and Min in °C), rainfall (mm), and relative humidity (%), were obtained from an automatic data logging system as well as various sources (https://weather.com, https://mausam.imd.gov.in/imd) and subsequently validated against the database of the Indian Meteorological Department. Data on these weather parameters were gathered from October 2020-21 to April 2021-22 and transformed into monthly averages to examine their correlation with the monthly mean incidence of wilt in chickpea.

Collection of Ascochyta blight disease incidence

Chickpea leaves displaying characteristic symptoms of ascochyta blight, typically characterized by necrotic elongated lesions (Figure 1), were collected and placed in polythene bags and labelled properly. After labelling, samples were transported to the lab and stored in a refrigerator until isolation was done. To isolate the *A. rabiei* fungus, the infected leaf samples underwent surface sterilization using sodium hypochlorite (0.5%) for a duration of 2 minutes, followed by two washes with sterilized distilled water. The samples were then inoculated onto Potato Dextrose Agar (PDA) medium under aseptic conditions. The plates were incubated for 8 days at a temperature range of 20 – 22°C, after which the mycelial growth was assessed. The pathogen was subsequently sub-cultured aseptically on PDA medium and slants in test tubes utilizing the single hyphal-tip culture technique (Brown 1924). The identification of the isolated fungus was based on the cultural characteristics observed from the onset of growth up to 14 days (Punithalingam and Holliday 1972).

Disease assessment

The severity of the disease was evaluated at seven-day intervals, commencing 30 days post-sowing. A total of twenty plants (JG-14, JG-16, JG-11, GNG-1581) from each plot (3 m × 1.2 m) were randomly tagged to monitor for symptoms of Ascochyta blight. The assessment of the disease began promptly following the emergence of symptoms on the upper leaves, utilizing a scale from 1 to 9, where 1 indicates no visible lesions on any plants and 9 signifies extensive lesions on all plants, with stem girdling affecting more than 50% of the plants and resulting in the death of many (Kaur *et al.* 2013). Following this, the severity ratings were transformed into a Percentage Severity Index (PSI) according to the formula established by Fininsa (2003).

$$PSI = (S_{nr} / N_{pr} \times M_{sc}) \times 100$$

Where S is the sum of numerical ratings, N is the number of nrpr plants rated and M is the maximum score on the scale.

Fig. 1. A-Ascochyta blight infected Chickpea Plant, B- Ascochyta blight symptom on chickpea leaf, c-Pure culture of pathogen isolated on PDA

Statistical analysis

Statistical analysis was conducted using SPSS 16.0 to examine the correlation and regression between disease incidence and weather parameters, aiming to elucidate the extent of their relationship.

RESULTS AND DISCUSSION

The occurrence of ascochyta blight was monitored throughout the *Rabi* season from 2020-21 to 2021-22, with the average monthly disease incidence (pooled) illustrated in Figure 2. Disease appeared during 31st meteorological week (2021-22 and 2022-23) with maximum temperature (T_{max}) 35 °C, minimum temperature (T_{min}) 24 °C, relative humidity 92% (RH I), and rainfall was 18 mm/week (Figure 2).

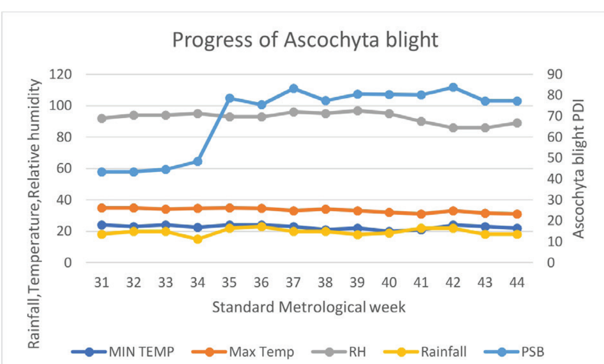

Fig. 2. Development of ascochytablight disease of chickpea

Disease increased progressively and reached its peak during the 42nd meteorological week (2021-22 and 2022-23), with maximum temperature 33.7 °C, minimum temperature 24.7 °C, relative humidity 86.14% and rainfall 22 mm/week. The correlation of Ascochyta blight disease intensity with weather parameters are presented in Table 2. For Ascochyta blight disease, the correlation studies indicated that rainfall has a positive correlation (0.38), minimum and maximum temperature have negative correlations (0.34 and 0.58) and RH has no correlation (0).

Table 2. Correlation coefficient (r) between weather parameters and Ascochyta blight of chickpea

Weather parameters	Correlation coefficient (r)
Min Temperature	-0.34
Max Temperature	-0.58
Relative Humidity	0
Rainfall	0.38

The present study has identified significant correlations between temperature and rainfall with disease incidence (DI) during the standard meteorological weeks (SMW). This time frame can be characterized as an epidemic window. During these weeks, the crop canopy plays a crucial role in maintaining relative humidity (RH), which allows for extended periods of leaf wetness. The primary factors contributing to disease development are RH and temperature. When both temperature and RH are favorable during the SMW, the risk of disease increases. Therefore, it is essential to monitor these two parameters closely during this period to implement appropriate management strategies.

The correlations presented above imply that lower temperatures could exacerbate the severity of Ascochyta blight. Previous research has demonstrated that cool and moist conditions facilitate the proliferation of this disease (Amerandra *et al.* 2024, Archana *et al.* 2025, Bal *et al.* 2008, Nalçacı *et al.* 2021). Nevertheless, the lack of a significant correlation between temperature variables and PSI in the V3 cultivar suggests that the relationship between temperature and the severity of ascochyta blight may be specific to certain cultivars, likely attributable to genetic differences in susceptibility to the disease (Chang *et al.* 2007, Nene *et al.* 2012, Sarwar *et al.* 2000, Md. Hedayetullah *et al.* 2024). Correlation network analysis revealed that all relative humidity (RH) components exhibited a significant positive association with the Plant Stress Index (PSI) across three chickpea cultivars, except for RH measured at 8 AM (RH 8), which showed no significant relationship with PSI. Among the environmental variables, RH demonstrated the strongest correlation with disease severity, underscoring the pivotal role of ambient humidity in facilitating the development and spread of *Didymella rabiei*, the causal agent of chickpea blight (Pande *et al*. 2005, Sharma and Ghosh, 2016). Previous research has similarly emphasized the significance of elevated RH levels for the germination of *Didymella rabiei* conidia and the progression of the disease (Coventry 2011, Jhorar *et al.* 1998, Pande *et al.* 2005).

The survey revealed a widespread occurrence of ascochyta blight disease in chickpea crops across various regions of Bundelkhand, exhibiting intensity levels ranging from low to high. The highest severity of ascochyta blight, recorded at 17.50%, was observed in the Mahoba district (JG-11), followed closely by Chitrakoot at 17.05% (JG-16) and Banda at 16.67% (GNG 1581). Conversely, the lowest severity, measured at 15.82% (JG-14), was found in the Hamirpur district. In summary, the severity of ascochyta blight in chickpea varied between 15.82% and 17.50% (Figure 3).

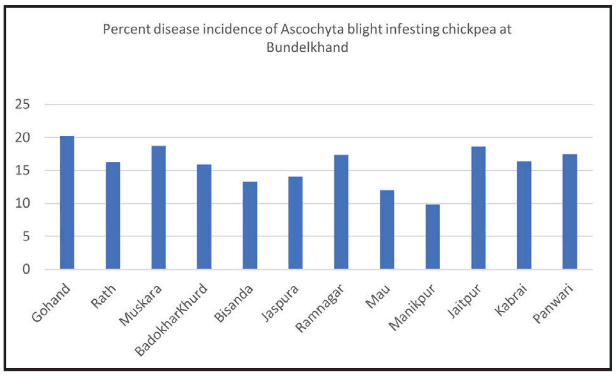

Fig. 3. Percent disease incidence of Ascochyta blight in selected blocks of the Bundelkhand region

The results of the study emphasize the intricate influence of weather conditions on the progression and severity of ascochyta blight in chickpea cultivars (JG-11, JG-14, JG-16 and GNG 1581). The application of multivariate statistical techniques, such as correlation networks, proved to be an essential approach for investigating the relationship between weather and disease, as well as for model development. Among the various parameters, temperature and rainfall were identified as the most significant factors contributing to disease spread. This investigation into the environmental factors affecting this disease is crucial for formulating more effective disease management strategies aimed at protecting chickpea production from the threat of ascochyta blight.

CONCLUSION

The present study shows that weather plays a big role in ascochyta blight affecting chickpea crops. Factors like temperature, humidity and rainfall drive up to 60% of the disease's spread, with higher humidity worsening it and warmer temperatures easing it. Disease severity ranged from 15.82% in Hamirpur to 17.50% in Mahoba. By tracking weather patterns, especially during key weeks, farmers can better predict and manage outbreaks. Using resistant chickpea varieties and timely fungicides can help protect crops and boost yields in the region.

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