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Agroclimatic Influence on Morphological Variability of Early Blight of Potato in Western Uttar Pradesh, India

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Abstract

Early blight caused by *Alternaria solani* is one of the most destructive foliar diseases of potato (*Solanum tuberosum* L.) and poses a serious threat to production in western Uttar Pradesh, India's dominant potato-growing region, where district-level variation in disease incidence and pathogen morphology remains poorly characterised. In the present study, nine isolates of *A. solani* (As1-As9) were collected from three agroclimatic districts Muradabad, Hapur, and Meerut during Rabi 2024-25 and 2025-26; field disease incidence was quantified as per cent disease intensity (PDI) using a standard 0-5 rating scale; and all isolates were characterised on Potato Dextrose Agar at 25 ± 1°C for colony colour, radial growth, conidial length, conidial width, and septal number, with Koch's postulates fulfilled for each isolate. The results revealed that disease incidence was highest in Meerut (mean PDI: 37.84-38.95%), followed by Muradabad (27.74-28.72%) and Hapur (22.34-23.85%), and that morphological variability was district-specific, with Meerut isolates producing the shortest and narrowest conidia (mean length: 66.78 µm; mean width: 24.56 µm), Muradabad isolates the longest conidia (mean: 72.17 µm), and Hapur isolates the widest conidia (mean: 30.71 µm), demonstrating that agroclimatic origin shapes both pathogen phenotype and field disease severity and thereby supporting the use of multi-location representative isolates in resistance screening and integrated disease management programmes.

1. Introduction

Early blight of potato (*Solanum tuberosum* L.), caused primarily by *Alternaria solani* (Ellis & Martin) Jones & Grout, represents one of the most economically damaging foliar diseases in global potato production (Van der Waals *et al.,*2001; Schmey *et al.,*2024). The pathogen is widely distributed across potato-growing regions of the world, and its epidemiological importa nce derives from its capacity to cause progressive defoliation during the critical tuber bulking phase, reducing photosynthetic area and resulting in yield losses of up to 50 per cent under severe epidemic conditions (Brouwer *et al.,*2021). In India, where potato occupies 2.35

million hectares with a total production of 60.54 million tonnes (*Agriculture statistics*, 2023), early blight ranks as one of the principal biotic constraints on productivity and crop quality. Uttar Pradesh, which alone contributes approximately one-third of the national potato output from 694.10 thousand hectares, is a region of particular epidemiological concern because disease-related losses here have consequences extending well beyond state boundaries to affect national seed supply, processing capacity, and ware potato trade (*Agriculture statistics*, 2023).

First, pathogen populations are not uniform entities; isolates collected from different agroclimatic origins, different host genotypes, or different field histories may differ substantially in morphological characters, growth physiology, sporulation capacity, aggressiveness, and sensitivity to fungicides (Kumar *et al.,*2016; Schmey *et al.,*2024). Second, variability in morphological traits such as conidial size and septation is not merely taxonomically relevant but may reflect ecophysiological adaptation to local environmental conditions of temperature, humidity, and host availability. Third, the degree of variability within a pathogen population in any given region directly determines the relevance of laboratory-based resistance screening and the durability of management recommendations derived from single-location isolate studies.

The concept of geo-pathological variation refers to the pattern of pathogen phenotypic or genotypic differentiation that can be attributed to geographical and climatic origin (Pugliese *et al.,*2009; Ivanović *et al.,*2022). In *A. solani*, earlier investigations in India have demonstrated that isolates from different states and agroclimatic zones differ in colony morphology, growth rates, conidial dimensions, and physiological responses (Kumar *et al.,*2016; Kumar and Singh, 2022; Marak *et al.,*2014). However, a systematic effort to link these morphological differences to both the precise agroclimatic origin of the isolates and the concurrently observed field disease incidence has not been reported from western Uttar Pradesh, a region representing the heart of the state's potato production belt.

The present investigation was conducted with the dual objective of characterising *A. solani* isolates from three agroclimatically distinct districts of western Uttar Pradesh at the morphological level and of exploring whether patterns of morphological diversity in the pathogen population are associated with the agroclimatic zone of collection and with the field disease incidence recorded at the respective collection sites. By integrating field disease assessment data with laboratory-based pathogen characterisation, the study aimed to generate a geo-pathological understanding of *A. solani* diversity in this region that can inform both the design of resistance screening experiments and the development of locally relevant integrated disease management programmes.

2. Materials and Methods

2.1 Agroclimatic Study Area and Site Selection

The study was conducted in three districts of western Uttar Pradesh representing distinct agroclimatic contexts: Muradabad, Hapur, and Meerut. These districts lie within the western plain zone of Uttar Pradesh and represent a gradient in potato production intensity, with Meerut historically recognised as a major production district and Hapur representing a zone of lower but expanding potato cultivation. Within each district, three villages were selected as sampling sites, and all subsequent field assessments and sample collections were conducted at these nine locations.

2.2 Field Disease Assessment

Disease incidence was assessed at each sampling site during Rabi 2024-25 and 2025-26. In each selected field, 100 leaves were examined at random, and each leaf was graded using a standard 0-5 disease rating scale, where 0 = no disease, 1 = up to 10% leaf area affected, 2 = 11-25%, 3 = 26-50%, 4 = 51-75%, and 5 = more than 75% leaf area affected. Per cent disease intensity (PDI) was calculated using Wheeler's (1969) formula:

$$PDI = \frac{\Sigma \text{ of disease ratings}}{\text{Total number of leaves observed} \times \text{Maximum disease grade}} \times 100$$

Disease assessments were carried out during the peak susceptible crop growth stage to ensure comparability across sites.

2.3 Collection of Diseased Material

Representative diseased potato leaves showing characteristic early blight symptoms were collected from each of the nine sampling sites during both years of the study. Samples were labelled with site information (district, village, latitude/longitude where possible, date, cultivar, and crop stage) and transported to the Department of Plant Pathology, CCS University, Meerut, in clean paper envelopes under cooled conditions to maintain sample integrity.

2.4 Isolation, Purification, and Pathogenicity Confirmation

Leaf bits of 3-5 mm were excised from the juncture of healthy and diseased tissue, surface sterilised with 1 per cent sodium hypochlorite for one minute, rinsed thrice in sterile distilled water, and blotted dry on sterile filter paper. The tissue pieces were transferred aseptically onto Potato Dextrose Agar (PDA) in Petri plates and incubated at 25 ± 1°C. Fungal colonies emerging from the tissue were purified using the hyphal tip method and maintained on PDA slants under refrigeration.

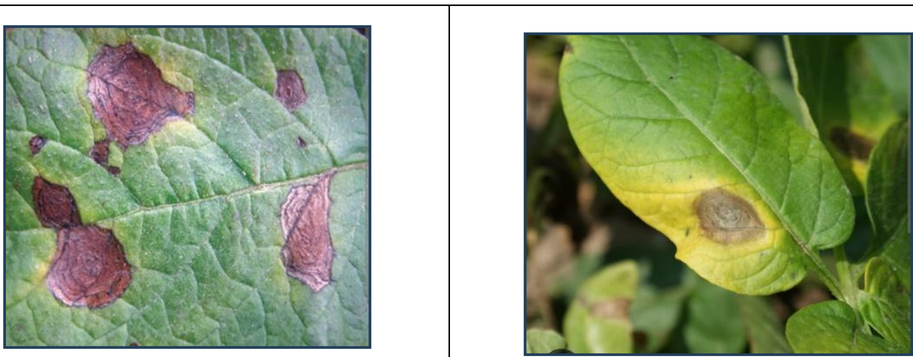

Fig1. Early blight symptoms observed consistently across all surveyed agro-climatic zones. (A) Advanced-stage lesion showing concentric rings and yellow chlorotic halo, typical of mid-to-late infection stages observed in high-incidence Meerut fields. (B) Early-stage lesion with brown necrosis surrounded by a prominent halo, representing typical symptom progression in low-incidence Hapur fields.

Pathogenicity of all nine isolates was established by inoculating healthy potato plants raised in sterilised soil in earthen pots with a spore suspension prepared from 10-day-old cultures. Inoculated plants were maintained under high humidity, and the development of symptoms was monitored for 10-14 days. The pathogen was re-isolated from artificially infected leaves and its morphological characters compared with the original isolate, thereby satisfying Koch's postulates.

2.5 Cultural and Morphological Characterisation

Each isolate was inoculated at the centre of PDA plates using a 5-mm mycelial disc and incubated at 25 ± 1°C. Colony characters (colour, texture, margin, sporulation) and radial growth (mean of two perpendicular diameters at full growth) were recorded. Temporary mounts of mature cultures were prepared in lactophenol, cotton blue and examined under a calibrated compound microscope. A minimum of 30 conidia per isolate were measured for each of the following characters: conidial length (µm), conidial width (µm), number of transverse (horizontal) septa, and number of longitudinal (vertical) septa. Beak morphology was noted qualitatively.

2.6 Geo-Pathological Analysis

To examine the relationship between agroclimatic origin, morphological characters, and field disease incidence, the morphometric data for all nine isolates were organised by district of origin and compared with the mean PDI recorded at the respective collection sites. Descriptive statistics (mean, range) were calculated for each morphometric character within each district group. The consistency of PDI rankings across the two seasons was also evaluated. Patterns of co-variation between morphological traits and disease incidence were examined through comparative tabulation, and notable associations were interpreted in the context of the agroclimatic characteristics of each district.

3. Results

3.1 Field Disease Incidence Across Agroclimatic Zones

The percentage disease intensity of early blight varied significantly among the three surveyed districts and among villages within each district (Table 2). Meerut consistently recorded the highest disease incidence over both years of the study. The mean PDI in Meerut ranged from 37.84 per cent in 2023-24 to 38.95 per cent in 2024-25, with individual village PDI values ranging from 33.84 to 42.42 per cent across both years. The village of Machhra recorded the maximum disease incidence among all surveyed sites in both years (41.98% and 42.42%, respectively).

Muradabad exhibited intermediate levels of disease, with a mean PDI of 27.74 per cent in 2024-25 and 28.72 per cent in 2025-26. Among the sampled villages in Muradabad, Lodhipur Rajput recorded the highest disease incidence (31.43% and 32.00%), while Gindora recorded the lowest (21.59% and 22.45%). Hapur showed the lowest disease incidence among the three districts, with mean PDI values of 22.34 and 23.85 per cent in the two survey years. Kathikhera was the most severely affected village in Hapur (26.16% and 27.42%), while Rampur recorded the minimum incidence (18.77% and 20.71%). The ranking of districts for disease incidence was consistent across both survey years: Meerut > Muradabad > Hapur.

Table 2. Per cent disease intensity (PDI) of early blight of potato at different collection sites in western Uttar Pradesh during Rabi 2024-25 and 2025-26, and associated isolate designations.

District	Village	Isolate	PDI 2024-25 (%)	PDI 2025-26 (%)	Mean PDI (%)
Muradabad	Lodhipur Rajput	As1	31.43	32.00	31.72
Muradabad	Gindora	As2	21.59	22.45	22.02
Muradabad	Dhanpura	As3	30.21	31.71	30.96
Muradabad Mean			**27.74**	**28.72**	**28.23**
Hapur	Kathikhera	As4	26.16	27.42	26.79
Hapur	Tatarpur	As5	22.11	23.41	22.76
Hapur	Rampur	As6	18.77	20.71	19.74
Hapur Mean			**22.34**	**23.85**	**23.10**
Meerut	Kharkhauda	As7	33.84	35.44	34.64
Meerut	Machhra	As8	41.98	42.42	42.20
Meerut	Rajpura	As9	37.72	39.00	38.36
Meerut Mean			**37.84**	**38.95**	**38.40**

Note: PDI = Per cent Disease Intensity calculated by Wheeler's (1969) formula using a 0-5 scale; n = 100 leaves per site per assessment.

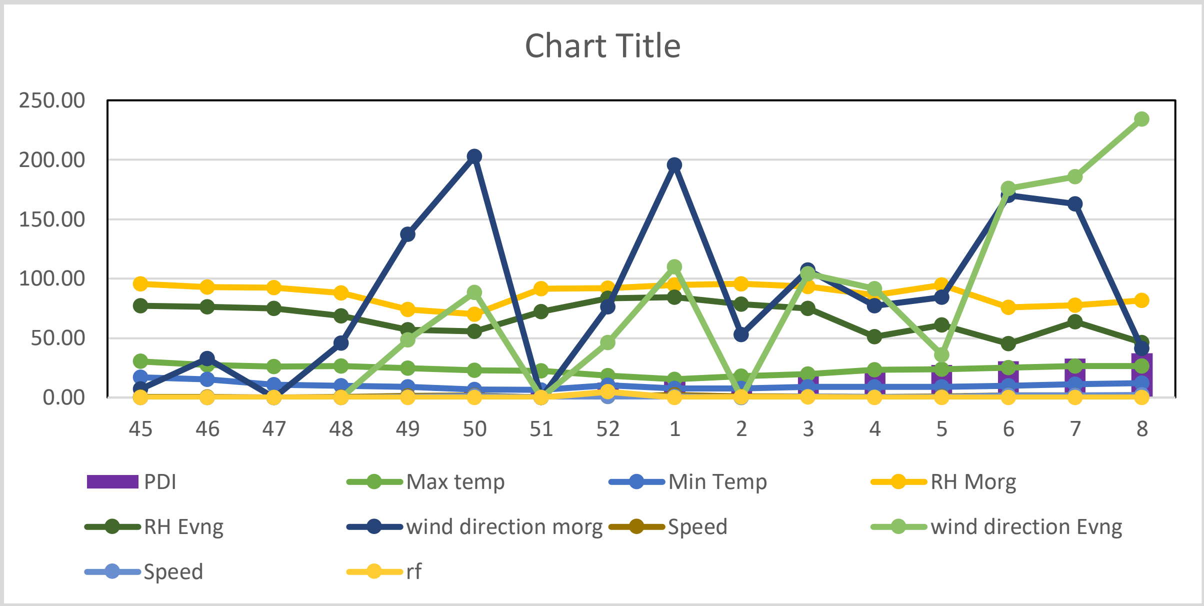

Fig 2. Influence of Weather Parameters on the Progression of Early Blight Disease Severity (PDI) in Potato during Different Standard Meteorological Weeks (SMW)Pradesh

3.2 Cultural Characteristics of Isolates by Agroclimatic Zone

Colony colour differed both among individual isolates and among the three district groups. Among Muradabad isolates (As1-As3), As1 produced greyish white colonies, As2 exhibited light grey colonies, and As3 produced distinctly black colonies. The Hapur isolates (As4-As6) showed blackish white colonies for As4 and As5, while As6 produced greyish white colonies. The Meerut isolates (As7-As9) showed grey (As7), greyish white (As8), and light grey (As9) colony colours. Across all isolates, colony texture was cottony to powdery and colony margins were entire to slightly irregular.

Radial growth of the isolates ranged from 79.15 mm (As8, Meerut) to 83.37 mm (As4, Hapur). Muradabad isolates recorded radial growth values of 82.36, 81.80, and 80.34 mm for As1, As2, and As3, respectively, yielding a district mean of 81.50 mm. Hapur isolates recorded radial growth of 83.37, 80.19, and 81.50 mm for As4, As5, and As6, respectively, with a district mean of 81.69 mm. Meerut isolates recorded 80.12, 79.15, and 81.72 mm for As7, As8, and As9, respectively, with a district mean of 80.33 mm. Thus, while differences were modest, Meerut isolates collectively showed somewhat lower radial growth than their counterparts from Muradabad and Hapur.

3.3 Morphological Characteristics by Agroclimatic Zone

Morphometric analysis of conidia revealed biologically meaningful differences among isolates both within and between districts (Table 3). Conidial length ranged from 63.60 µm (As9, Meerut) to 75.00 µm (As2, Muradabad). The mean conidial length for Muradabad isolates (As1-As3) was 72.17 µm, for Hapur isolates (As4-As6) was 70.65 µm, and for Meerut isolates (As7-As9) was 66.78 µm. Meerut isolates thus produced the shortest conidia on average among the three district groups.

Conidial width showed pronounced variation, ranging from 23.61 µm in As8 (Meerut) to 35.76 µm in As6 (Hapur). The mean conidial width for Muradabad isolates was 27.03 µm, for Hapur isolates was 30.71 µm, and for Meerut isolates was 24.56 µm. Hapur isolates were notably wider in their conidia than isolates from the other two districts, while Meerut isolates were the narrowest. The number of horizontal (transverse) septa ranged from 1 to 2 across the collection. Isolates As2, As3, As7, and As8 each bore two horizontal septa, while the remaining isolates each bore one horizontal septum. The number of vertical (longitudinal) septa ranged from 4 to 6. Isolate As5 (Hapur) possessed 6 longitudinal septa, which was the highest number recorded; As3 (Muradabad), As8 and As9 (Meerut) possessed 5 longitudinal septa, while the remaining isolates each possessed 4 longitudinal septa.

Table 3. Morphological characters of *Alternaria solani* isolates organised by the agroclimatic zone of collection.

District	Isolate	Collection Village	Conidial Length (µm)	Conidial Width (µm)	H. Septa	V. Septa	Colony Diam. (mm)	Colony Colour
Muradabad	As1	Lodhipur Rajput	68.50	25.35	1	4	82.36	Greyish white
Muradabad	As2	Gindora	75.00	26.50	2	4	81.80	Light grey
Muradabad	As3	Dhanpura	73.00	29.25	2	5	80.34	Black
Muradabad Mean			**72.17**	**27.03**			**81.50**	
Hapur	As4	Kathikhera	63.62	27.85	1	4	83.37	Blackish white

Hapur	As5	Tatarpur	74.66	28.53	1	6	80.19	Blackish white
Hapur	As6	Rampur	73.67	35.76	1	4	81.50	Greyish white
Hapur Mean			**70.65**	**30.71**			**81.69**	
Meerut	As7	Kharkhauda	65.63	24.74	2	4	80.12	Grey
Meerut	As8	Machhra	71.11	23.61	2	5	79.15	Greyish white
Meerut	As9	Rajpura	63.60	25.32	1	5	81.72	Light grey
Meerut Mean			**66.78**	**24.56**			**80.33**	

Note: H. Septa = horizontal (transverse) septa; V. Septa = vertical (longitudinal) septa. Colony diameter is the mean of two perpendicular measurements at full growth on PDA at 25 ± 1°C. All conidial measurements are means of 30 conidia per isolate.

3.4 Summary of Geo-Pathological Patterns

The data assembled across Tables 2 and 3 reveal a nuanced picture of geo-pathological variation. Meerut, which recorded the highest field disease incidence (mean PDI: 38.40%), harboured isolates with the shortest conidia (mean length: 66.78 µm) and narrowest conidia (mean width: 24.56 µm) among the three districts, but also the lowest radial growth (mean: 80.33 mm). Muradabad, with intermediate disease incidence (mean PDI: 28.23%), was associated with isolates bearing the longest conidia on average (mean length: 72.17 µm) and intermediate conidial width (mean: 27.03 µm). Hapur, which recorded the lowest field disease incidence (mean PDI: 23.10%), harboured isolates with the widest conidia (mean width: 30.71 µm) and the highest individual radial growth (As4: 83.37 mm). These patterns suggest that conidial size per se does not predict field disease severity in a simple linear manner, and that other factors, including agroclimatic conditions, cropping intensity, host genotype, and inoculum pressure, mediate the ultimate expression of field disease.

4. Discussion

The present investigation adopted an integrated geo-pathological approach by linking morphological characterisation of *Alternaria solani* isolates with field disease incidence data, providing systems-level understanding of how agroclimatic context shapes pathogen phenotype and epidemic severity. This integration of laboratory microbiology with field epidemiology is essential for generating actionable knowledge for regionally targeted disease management. The consistent ranking of districts for disease incidence across both survey years, Meerut (38.40% mean PDI) > Muradabad (28.23%) > Hapur (23.10%), reflects underlying differences in agroclimatic conditions, cropping intensity, cultivar choices, and management practices. Meerut's position as the highest-incidence district aligns with its status as Uttar Pradesh's premier potato-growing zone, combining intensive year-round cultivation with multiple crops per annum, monoculture legacy maintaining high baseline inoculum, high irrigation frequency creating extended leaf wetness periods, and commercially grown varieties often lacking early blight resistance. Kumar *et al.* (2017) documented that disease severity increased significantly with rainfall, high relative humidity, and low sunshine hours, conditions frequent in the Indo-Gangetic plains during the winter potato season. Manjamma *et al.* (2024) reported similar early blight severity patterns in Karnataka (5.13-30.33%), with the highest-incidence districts showing identical agronomic profiles: intensive cultivation, irrigation-dependent systems, and limited resistant variety adoption. The parallelism between district-ranking patterns suggests universal agroclimatic and socioeconomic drivers of *A. solani* epidemics in India's potato belt.

A striking finding is that Meerut isolates (high-incidence zone) produced the shortest and narrowest conidia (mean length: 66.78 µm; mean width: 24.56 µm) while Hapur isolates (low-incidence zone) produced the widest conidia (mean width: 30.71 µm), suggesting complex selection mechanisms. Intense selection pressure from frequent disease cycles, high inoculum turnover, and repeated fungicide applications in high-incidence zones may select for isolates with smaller, readily dispersed propagules. Smaller conidia possess favourable aerodynamic properties for wind dispersal, and in intensive monoculture with proximate susceptible hosts, rapid local spread confers a selective advantage (Bessadat *et al.,*2017), aligning with general parasite evolution principles favouring transmission efficiency in high-transmission environments (Anderson & May, 1982). Conversely, lower-incidence environments may favour larger, nutrient-rich conidia surviving unfavourable conditions. Gimenez *et al.* (2025) demonstrated that conidial size varies with temperature and humidity during conidiogenesis, with cooler, drier conditions favouring smaller conidia, potentially explaining regional differences if microclimates vary during peak potato season. Additionally, host-pathogen interactions may impose differential selection; most Meerut production concentrates on narrow commercial variety sets, while Hapur cultivation encompasses broader variety ranges with partial early blight resistance. Meena and Yadav (2022) reported differential resistance responses of potato genotypes to *A. solani*, suggesting active host-pathogen coevolution shaping local populations.

However, a counterintuitive pattern emerges: Meerut's higher disease incidence paradoxically associates with smaller conidia, while Hapur's lower incidence associates with larger conidia, challenging assumptions about direct conidial size-aggressiveness correlations. Wang *et al.* (2019) similarly found conidial size poorly predicted field aggressiveness in *Alternaria alternata*, with pathogen-host-environment interactions proving more informative. Field disease incidence reflects the disease triangle outcome: high Meerut incidence may result not from superior conidial morphology but from overwhelming inoculum pressure in intensive zones, prevalence of highly susceptible cultivars enabling rapid epidemic expansion, and warm, humid microclimate favouring germination and infection. Conidial size represents fitness trade-offs: larger conidia contain nutrients and enhance desiccation survival but require greater metabolic investment and disperse less efficiently; smaller conidia aerosolise readily and spread efficiently but face greater UV and osmotic stress. In high-incidence zones where transmission-related fitness dominates, selection favours smaller conidia; in lower-incidence zones where stress tolerance matters more, selection favours larger conidia.

The geo-pathological variation documented here has direct practical implications for resistance screening design. Traditional single-isolate protocols risk misclassifying resistance levels if that isolate does not represent the regional population. Multi-isolate approaches evaluating genotypes against composite series representing local diversity are strongly warranted. Chakraborty *et al.* (2022) and Meena and Yadav (2022) demonstrated differential resistance contingent on isolate source, with genotype-by-isolate interactions substantially inflating or deflating resistance stability estimates. Multi-isolate screening identifying genotypes maintaining stable resistance across pathogen populations improves durability likelihood. The nine characterised isolates provide a screening set foundation; ideally, composite inoculum should include isolates differing in fungicide sensitivity status, since fungicide-resistant *A. solani* strains are documented (Brouwer *et al.,*2021; Patel & Gohel, 2024), and including resistant pathotypes prevents misleading results if fungicide is used during evaluation.

Modern pathological practice demands integration of classical morphological and epidemiological approaches with molecular characterisation and computational modelling. Schmey *et al.* (2024) emphasised that the early blight complex encompasses multiple *Alternaria* species, with morphology alone being insufficient for reliable species identification. ITS sequencing, rapid and inexpensive, definitively confirms species identity and reveals cryptic species or genetically differentiated subspecific lineages morphologically indistinguishable. Comparative genomic analysis could reveal the genetic architecture underlying morphological variation; genome-wide association studies identifying loci controlling conidial size, pigmentation, and growth rate would indicate whether traits are tightly linked or independently segregating, revealing whether variation reflects genetic differentiation or phenotypic plasticity. Integration of morphological and epidemiological data with spatial and weather data using GIS and statistical modelling could yield predictive disease risk maps across western Uttar Pradesh. Kumar *et al.* (2017) developed epidemiological models incorporating temperature, humidity, and rainfall predicting *A. solani* infection periods; extension incorporating cultivar deployment patterns, inoculum pressure, and fungicide use would greatly facilitate management intervention targeting.

The investigation provides suggestive evidence that *A. solani* populations undergo localised coevolution with predominant potato cultivars. Meerut's high-incidence zone, concentrated on narrow, highly susceptible variety ranges, shows lower isolate diversity in conidial size distribution, suggesting more genetically homogeneous local populations, while Hapur's broader cultivar diversity selects for more heterogeneous pathogen populations overcoming resistance in multiple genetic backgrounds. This aligns with host-pathogen coevolution theoretical literature (Frank, 1996; Lively & Dybdahl, 2000) and empirical pathogen population structure studies. Fernández *et al.* (2020), examining *Phytophthora infestans* diversity across Brazilian potato zones, found monoculture zones harboured lower diversity and less complex virulence profiles than diversified systems. Meerut isolates showing lower conidial width diversity (range: 23.61-25.32 µm) compared with Hapur (range: 27.85-35.76 µm) may reflect similar processes. Western Uttar Pradesh's agroclimatic setting-cool dry autumns followed by mild, moist winters and warm, dry springs-creates a distinct selective environment compared with other Indian potato regions. The Indo-Gangetic plains' seasonal pattern suits potato cultivation, creating conditions favourable for *A. solani* during January-March peak cropping when moderate temperatures (15-23°C) and high relative humidity maximise infection efficiency (Lal *et al.,*2022). This agroclimatic template shapes overall disease pressure and locally adapted population phenotypic characteristics. Isolates selected over decades for the region's specific temperature-humidity-light regime may differ morphologically from those adapted to warmer, drier off-season conditions.

The geo-pathological understanding supports nuanced region-specific integrated pest management (IPM) rather than uniform state-wide recommendations. For Meerut's high-incidence zone, strategies should emphasise highly or moderately resistant varieties combined with regular fungicide schedules, close fungicide resistance monitoring, and cultural practices reducing baseline inoculum (haulm destruction, crop rotation, volunteer potato removal). For lower-incidence zones like Hapur, management could rely more on moderately resistant varieties and judicious rather than calendar-based fungicide application, with deployment triggered by disease forecast models incorporating weather data. Understanding that local pathogen populations are genetically differentiated and agroclimatically adapted argues for maintaining diverse potato cultivars within regions rather than concentrating on narrow, high-yielding susceptible varieties. Varietal diversification creates complex fitness landscapes, inhibiting rapid virulent pathogen spread and has been shown empirically to reduce epidemic severity and slow fungicide resistance evolution (Wolters *et al.,*2021; Schmey *et al.,*2024). While the investigation provides valuable *A. solani* characterisation for western Uttar Pradesh, generalizability beyond the study region should be considered. Sampling was limited to two Rabi seasons (2024-25, 2025-26); consistency of district disease rankings between years suggests robust patterns, but longer-term monitoring strengthens confidence in stability. The nine isolates represent convenience samples from specific villages; comprehensive random sampling across larger village numbers per district would more representatively characterise local populations. Future investigations should expand geographical and temporal scope, incorporate molecular characterisation alongside morphology, and conduct direct pathogenicity and fungicide sensitivity assays. Such comprehensive studies would generate a complete understanding of *A. solani* population structure and dynamics in Uttar Pradesh, providing evidence for system-level management decisions.

5. Conclusions

The present investigation established a geo-pathological framework for understanding *A. solani* diversity in western Uttar Pradesh by linking the morphological characteristics of nine isolates to their agroclimatic origin and to the field disease incidence recorded at the collection sites. Early blight incidence was consistently highest in Meerut (mean PDI: 38.40%), followed by Muradabad (28.23%) and Hapur (23.10%). Morphological analysis revealed that Meerut isolates produced shorter and narrower conidia on average than isolates from Muradabad or Hapur, while Hapur isolates exhibited the widest conidia and the highest individual radial growth values. These patterns indicate that agroclimatic origin is an important determinant of pathogen phenotype and cannot be ignored when designing disease management experiments or interpreting results from isolate-based studies. The findings strongly support the use of multiple, location-representative isolates in resistance screening and fungicide evaluation programmes, and provide a morphological baseline for future molecular and aggressiveness-based studies of *A. solani* in this region.

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