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A field-based assessment of maize leaf diseases in four districts of Kandahar Province, Afghanistan

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A B S T R A C T

Maize (*Zea mays* L.) is the second most important crop in Afghanistan's cereal production system, enhancing food security, animal production, and the sustainability of rural livelihoods. Maize productivity in Afghanistan is low due to various biotic stresses, including leaf diseases. The dataset report of the detection of maize leaf diseases was conducted during the 2025 growing season of maize in the top maize-producing districts of Kandahar province, Afghanistan. Under natural growing conditions, high-quality images of maize leaves were taken, including geo-referenced information about the occurrence of maize leaf diseases in the fields. A total of 1,027 images of maize leaves were taken, classified into three different classes: healthy leaves, leaf spot-infected leaves, and leaf blight-infected leaves. Leaf blight and leaf spot diseases were detected in maize fields throughout the selected districts of Kandahar Province, Afghanistan. Leaf blight and leaf spot diseases were more frequently observed in maize fields with high plant density and poor crop management practices. The dataset can serve as a valuable resource for plant disease detection, agricultural research, and the development of machine learning and deep learning models for maize disease identification. Foliar diseases of maize, including leaf blight and leaf spot, are one of the major constraints of maize cultivation in the province. This study provides a geo-referenced maize leaf disease dataset that can support disease monitoring, early detection, spatial analysis of disease occurrence, and the development of machine learning-based decision-support tools for integrated disease management in Afghanistan.

Keywords: maize, leaf diseases, field-based assessment, Kandahar province

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1. INTRODUCTION

Agriculture serves as a critical pillar of global food security, employment generation, and economic development. Nevertheless, accelerating population growth and increasing food demand have intensified the need for sustainable agricultural intensification to ensure long-term productivity and resource conservation (Eli-Chukwu, 2019; S. Sharma et al., 2023). With numerous uses in food, feed, and as an industrial raw material, maize is among the most significant staple crops in the world (Entuni & Zulcaffle, 2022; Idress et al., 2024; Mohanty et al., 2023). Plant illnesses and pest infestations are significant obstacles to agricultural productivity, frequently resulting in reduced yields and substantial economic losses (Barman et al., 2024; Krishna et al., 2025; Upadhyay et al., 2025).

In Afghanistan, maize is the most important cereal crop after wheat (Elham et al., 2020; Habibi et al., 2025; R. Sharma et al., 2018). Aside from human consumption, the crop plays an important role in the production of feed for poultry, biofuel, animal feed, and other uses (Elham et al., 2023). In this country, maize is cultivated for both grain and fodder purposes, playing an important role in human nutrition as well as livestock and poultry feeding. The total area under maize cultivation is approximately 92,144 hectares, yielding about 180,000 tons of grain annually. However, the national average yield remains relatively low at around 1.95 t ha^{-1}, highlighting the need for improved production practices and effective crop management strategies (Ahmadi et al., 2024), and multiple factors, including low access to improved varieties, poor-quality seeds, low-fertility soil, and inadequate use of fertilizers, limit maize yields in this country. In addition, maize productivity is adversely affected by suboptimal agronomic practices, water scarcity, traditional irrigation methods, and biotic stresses, including diseases, insect pests, and weeds (Mozafari et al., 2020).

The cultivation of maize in Kandahar province is extensive, covering several districts due to the short growth period, water stress resistance, and the crop's multifunctional uses. The cultivation of maize contributes to the livelihood of the people, as the yield increases the availability of food and income for the smallholder farmers. However, the yield of maize in Kandahar is much lower compared to the global standard, mainly due to the limited access to improved technology, improper management, and the effects of crop diseases, pests, and weeds (Mozafari et al., 2020). Among the biotic factors affecting the yield of the crop, leaf disease is considered the most devastating. Among the major biotic constraints affecting maize production, foliar diseases such as leaf blight and leaf spot are particularly important. Maydis leaf blight is recognized as one of the most destructive foliar diseases of maize worldwide and, under favorable environmental conditions, may cause grain yield losses exceeding 40% (Kumar et al., 2022).

Despite the importance of maize production in Kandahar Province, Afghanistan, there is limited field-based information on the occurrence and distribution of maize leaf diseases under natural growing conditions. Most previous studies have relied on experimental datasets or generalized regional information, which may not accurately reflect disease occurrence under actual field conditions. High-resolution field image assessments provide valuable opportunities for documenting disease symptoms and their spatial distribution, thereby supporting disease surveillance and management. Therefore, this study aimed to assess the prevalence and distribution of maize leaf diseases across four major maize-growing districts of Kandahar Province and to provide baseline data for future disease monitoring and management programs.

2. MATERIALS AND METHODS

2.1 STUDY AREA

Study was conducted through four selected districts of southern Afghanistan's Kandahar province during the 2025 maize-growing season. The area which appears in Figure 1 as a separate zone between Uruzgan to the north, Zabul to the east, and Helmand to the west. The territory, which extends over 54000 square kilometers, contains extensive areas of dry terrain. The region experiences

high temperature conditions throughout most of the year because precipitation occurs infrequently and humidity dissipates quickly under intense sunlight. The agricultural system depends predominantly on controlled irrigation systems because natural rainfall occurs only during brief moments when rain falls from the clouds. The primary agricultural product of this region consists of maize, which farmers cultivate through controlled irrigation systems that supply their fields with water. The region depends on agriculture as its main economic activity, which requires water resources from the Arghandab River and the flow management systems of the Dahla Dam. The primary agricultural products for the region include wheat and maize, together with assorted fruits and multiple vegetable types. The crop faces multiple threats, which originate from biological organisms and environmental factors that include drought conditions and diminished soil quality, and the emergence of foliar diseases, which cause leaf blight and leaf spot. The study was conducted in four districts of Kandahar Province (Dand, Panjwayi, Arghandab, and Zhari), which were selected for the field assessment of maize leaf diseases.

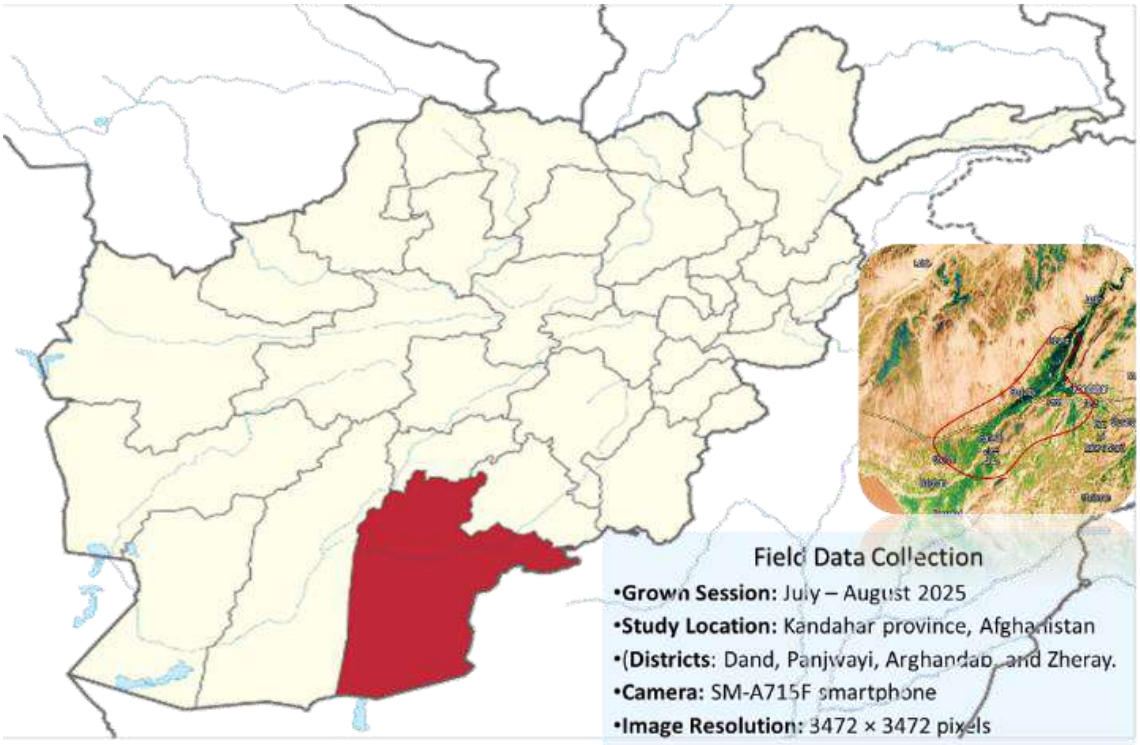


Figure 1. Study area map of Kandahar province, Afghanistan.

2.2 Field-Based Data Collection

Field observations were conducted during the 2025 maize growing season to document the occurrence of maize leaf diseases under natural farming conditions in Kandahar Province, Afghanistan. Maize fields were selected from four major maize-producing districts, and field visits were carried out during critical crop growth stages to identify and record disease symptoms. Visual assessments were performed to identify symptomatic and healthy maize leaves, and representative samples were documented through high-resolution digital imaging under natural field conditions. Only actively growing maize plants were considered to ensure an accurate representation of disease occurrence in fields. All images were captured in situ and stored in JPEG format with corresponding geographic coordinates (GPS) to accurately record sampling locations. Data collection was conducted in four major maize-producing districts of Kandahar Province: Dand (31.570559°N, 65.686175°E), Panjwayi (31.5104304°N, 65.4143471°E), Arghandab (31.659291°N, 65.642287°E), and Zhari (31.625849°N, 65.543815°E). These districts represent diverse agricultural environments and management practices, providing variability in agro-climatic conditions and disease occurrence.

The dataset comprises three statuses of maize leaves: healthy leaves, leaf spot-infected leaves, and leaf blight-infected leaves. All images were acquired using a Samsung SM-A715F smartphone equipped with a 12-megapixel camera, producing images with a resolution of 3472 × 3472 pixels. Image acquisition was performed during July and August 2025, when disease symptoms were clearly visible and distinguishable. Image acquisition was performed during both morning and afternoon periods under different natural lighting and field conditions to ensure a diverse and representative dataset. The resulting geo-referenced image dataset was organized and made publicly available through the Mendeley Data repository (Rafi, 2026), providing a valuable resource for maize disease detection, computer vision research, and the development of artificial intelligence-based decision-support systems for crop health monitoring.



Figure 2. Representative field images of maize cultivation in Kandahar province, Afghanistan

2.3 Disease Identification and Assessment

Maize leaf diseases were identified through visual assessment of characteristic disease symptoms, including lesion shape, color, size, and distribution patterns on leaf surfaces. Based on symptom characteristics, two major disease categories were recorded: leaf blight and leaf spot. Disease incidence was determined by counting infected plants in each field, whereas disease severity was assessed based on infected leaf area. Field assessments were conducted across all study sites to ensure consistency and enable comparisons among districts.

2.4 Data Analysis

Collected field data were organized and summarized to identify which maize leaf diseases existed in the study areas, how common they were, and where they occurred. The researchers used descriptive statistical methods to study how diseases spread and progressed in different districts. The researchers used tables and figures to display their results, which showed how disease pressure and distribution patterns changed. The study used observational field research to examine general patterns and differences between locations instead of testing specific treatment methods.

3. RESULTS

The field survey conducted across multiple villages within the four districts of Kandahar Province revealed a high prevalence of maize leaf diseases during the 2025 growing season. The observed maize fields showed two main leaf diseases, which included leaf blight and leaf spot, according to field studies and image documentation. Healthy maize leaves were present in all locations, but their distribution showed significant differences across different areas. The research team used GPS coordinates to create precise collection site maps for each image. A total of 1,027 maize field images were acquired from four districts of Kandahar Province (Dand, Panjwayi, Arghandab, and Zhari), including adjacent urban villages, to establish an initial dataset for maize leaf disease detection.



Figure 3. Workflow for accessing the maize leaf disease dataset from Mendeley Data, extracting image metadata, and identifying GPS-based district locations in Kandahar province, Afghanistan.

The workflow shown in Figure 3 shows how users access the maize leaf disease image dataset, which exists in Mendeley Data. The process starts with downloading the dataset, which users need to decompress. Users can open single images through their photo software to check the EXIF metadata that exists in each image. The researchers extracted key image attributes, which included capture date, device information, and GPS coordinates, to identify the corresponding districts within Kandahar Province for geospatial analysis. Table 1 summarizes the number of images collected per district, city, and village, along with GPS coordinates (latitude and longitude) for each collection site

Table 1 Number of collected images from districts and city villages of Kandahar province with their classification status (spot, blight, and healthy)

Province	District	Total images	Status
Kandahar	Dand	185	Spot, Blight, and healthy
	Panjwayi	216	Spot, Blight, and healthy
	Arghandab	286	Spot, Blight, and healthy
	Zhari	151	Spot, Blight, and healthy
	Villages of the City	189	Spot, Blight, and healthy

The complete dataset has three distinct status categories, which include healthy leaves, leaves infected with leaf spot disease, and leaves infected with leaf blight, as shown in Figure 4. The distribution of both leaf spot and leaf blight diseases extended through all areas where maize was cultivated, which demonstrated that these diseases have become established permanent problems within the region. The agricultural diseases that farmers experienced throughout the growing season showed different symptoms at various plant development stages. The spatial analysis of disease spread patterns revealed that different villages and fields experienced different rates of disease transmission. Areas with dense plant populations and insufficient crop management practices experienced higher disease intensity in maize fields. Disease symptoms were observed in maize fields across the study sites; however, further efforts are required to improve knowledge of disease identification, causes, and management practices. The restricted knowledge of farmers about leaf disease identification and control methods resulted in widespread leaf disease distribution throughout the study area.



a **b** **c**

Figure 4. Representative maize leaf images illustrating three classes used in the results: **(a)** blight-infected leaf, **(b)** spot-infected leaf, and **(c)** healthy (normal) leaf.

4. Discussion

The research findings show that the combination of maize leaf blight and leaf spot diseases functions as the most common foliar disease that affects maize cultivation throughout the Kandahar Province study area. The diseases that spread naturally throughout field environments serve as primary biotic factors that limit maize farming in the area. The research results from southwestern Ethiopia show that leaf blight and leaf spot diseases serve as major yield-limiting factors because these diseases reduce photosynthetic capacity and grain yield (Abera et al., 2025). The restricted availability of agricultural extension services throughout Kandahar Province creates additional obstacles for farmers who need to develop effective disease control procedures.

The combination of environmental factors, variety resistance, farming practice decisions, crop management methods, and irrigation systems determines the level of disease outbreaks in agricultural fields. The findings of this study revealed that fields with limited crop management practices, inadequate crop protection measures, and the absence of disease control strategies exhibited higher disease incidence. (Nsibo et al., 2024) reported similar findings about maize foliar fungal pathogens, which persist in sub-Saharan Africa due to poor disease management practices and faulty farming

methods that lead to leaf blight and leaf spot disease outbreaks. This study demonstrates that insufficient disease control methods increase disease outbreaks that occur in agricultural fields. Agricultural drought has emerged as the primary danger that affects rain-fed maize systems because its effects differ between various growth periods and different geographic areas. A dynamic drought risk assessment study conducted in Jilin Province, China, demonstrated that drought risk changes significantly during maize development stages and is strongly influenced by climatic variability and regional characteristics (Zhang et al., 2019).

The present study, supported by previous research, emphasizes the importance of considering growth stages and geographic variability for improving drought resilience and drought management in maize. The study found that farmers had minimal understanding of maize leaf diseases, which represents a critical finding. The farmers detected abnormal leaf symptoms, but they could not identify specific disease types or predict how these diseases would affect their crop production. The agricultural systems of developing countries show knowledge deficiencies that require extension programs that can teach farmers about disease identification and prevention, and integrated management methods. The exclusion of maize rust from the dataset demonstrates that the agro-climatic conditions of Kandahar Province, which include high temperatures, low rainfall, and low relative humidity, match the area's natural environment. The environmental conditions create a situation that prevents rust development, thus demonstrating the need for actual field studies to determine disease presence. Proposed study results demonstrate that field-based image data collections or datasets provide accurate disease information, which helps farmers make scientifically supported agricultural choices.

This study provides valuable insights into the occurrence of maize leaf diseases in Kandahar Province; however, several limitations should be acknowledged. First, data collection was conducted during a single growing season (2025), which limits the ability to evaluate temporal variations in disease occurrence across multiple years. Future studies incorporating multi-seasonal and multi-year datasets would provide a more comprehensive understanding of disease prevalence and distribution patterns. Second, disease identification was based primarily on visual symptom assessment under field conditions. Although this approach reflects practical field scouting procedures, it may introduce uncertainty when differentiating diseases with similar symptom characteristics. Future research should incorporate laboratory-based pathogen confirmation techniques, including microscopic examination and other diagnostic methods, to improve diagnostic accuracy. Third, the dataset was collected from selected maize-producing districts of Kandahar Province and may not fully represent the diversity of agro-ecological conditions across Afghanistan. Expanding data collection to additional regions with varying climatic conditions, cropping systems, and management practices would improve the representativeness and generalizability of the dataset.

Finally, while the dataset provides high-quality geo-referenced field images of maize leaf diseases, it does not include the development or validation of automated disease classification models. Future studies should utilize this dataset to develop and evaluate machine learning and deep learning approaches for disease detection, early warning systems, and decision-support tools for maize disease management. Continued research in this area will contribute to more effective disease monitoring and sustainable maize production in Afghanistan.

5. CONCLUSION

This study presents a geo-referenced field image dataset of maize leaf diseases collected from four major maize-producing districts of Kandahar Province, Afghanistan. Field observations confirmed the occurrence of two major foliar diseases, namely leaf blight and leaf spot, together with healthy maize leaves across the study area. The dataset was developed under natural field conditions and includes high-resolution images with corresponding geographic coordinates, providing valuable information on disease occurrence in maize-growing regions. The dataset contributes to addressing the limited availability of publicly accessible maize disease data from Afghanistan and supports future

research in plant disease detection, computer vision, and artificial intelligence applications in agriculture. Furthermore, the geo-referenced nature of the dataset enables spatial analysis of disease occurrence and may support the development of decision-support tools for crop health monitoring and disease management. Overall, this dataset establishes a foundation for future studies aimed at improving maize disease surveillance, developing automated disease detection systems, and enhancing sustainable maize production in Afghanistan.

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Data Availability Statement

The data that support the findings of this study are openly accessible. The dataset created and examined throughout the current research is stored in the Mendeley Data archive and may be reached via the DOI: https://doi.org/10.17632/zkgh9tddf6.1.

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AI Statement

Artificial intelligence tools were used only for language improvement and grammatical editing.

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