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Major Fungal Diseases of Common Bean Accessions Cultivated Under Medium Altitude Conditions in Tshilenge, Democratic Republic of Congo

Tshibamba Mukendi John[1;2*]; Kilolo Kamanda Promesse[1]

[1]Official University of Mbujimayi (UOM), DRC
[2]National Institute for Agronomic Study and Research (INERA), DRC

Corresponding Author: Tshibamba Mukendi John[1;2*]

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Abstract: The common bean is an important legume for human consumption and the second largest source of calories after maize. However, its production is subject to various constraints, including diseases, as with other legumes, primarily fungal, bacterial, and viral. Given the above, it is reasonable to assume that common bean accessions exhibit varying levels of tolerance to major fungal diseases, and that one common bean accession is tolerant to these diseases. This study aims to identify the major fungal diseases affecting common bean accessions and to determine which accession is tolerant to these diseases under mid-altitude conditions in Tshilenge, Democratic Republic of Congo. According to the results of this study, damping-off, angular leaf spot, and cercospora leaf spot are major fungal diseases identified on common bean accessions, and their incidence varies considerably among accessions. The accession most susceptible to damping-off is HC1 (46.1%), the most tolerant is HC3 (12.8%), and the most moderately susceptible are HC2 and HC4 (20.6%). For angular leaf spot, HC2 and HC1 are the most susceptible at 29.4% and 27.3%, respectively, while HC4 and HC3 are the most moderately susceptible at 22.5% and 20.8%, respectively. Regarding the incidence of cercospora leaf spot, HC1 is the most susceptible at 33%, while HC2 is the most moderately susceptible, and finally, HC3 and HC4 are the most tolerant at 18.3% and 21.7%, respectively.

Keywords: *Pathology, Fungal, Major, Accession, Bean, Common, Cultivated, Medium, Altitude.*

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I. INTRODUCTION

The common bean (Phaseolus vulgaris L.) is a legume native to temperate and tropical regions of the Americas, Africa, and Asia (Wortmann, 2006). In Africa, common bean cultivation is present in various agro-ecological zones at high and medium altitudes (Snapp et al., 2018).

The common bean is cultivated primarily because of its high protein (20% to 25%), iron, and fiber content, as well as its zinc, slow-release carbohydrates, and vitamins (Celmeli et al., 2018; Ntamwira et al., 2017; Rana et al., 2015). Globally, it ranks as the second most important source of calories after maize (Delhove et al., 2023).

Despite its importance for food and agriculture, common bean production faces various constraints, including diseases, as with other legumes, primarily caused by fungi (Meziadi et al., 2016; Martins et al., 2018), bacteria (Djeugap et al., 2014), and viruses (Mwaipopo et al., 2018).

Nearly twenty fungal pathogens have been identified on this crop, most of which are also present on other legumes (Goudjo et al., 2023). These fungal pathogens manifest in various ways on bean plants, inducing lesions of diverse forms affecting all plant organs, such as spots, streaks, necrosis, scorching, rot, wilting, yellowing, stunting, defoliation, and chlorosis (Atse et al., 2025; Goudjo et al., 2023; Mirindi et al., 2018).

Given the above, it is reasonable to assume that common bean accessions exhibit varying degrees of tolerance to major fungal diseases, and that one common bean accession is tolerant to these diseases.

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It is in this context that the present work is situated, which aims to identify the major fungal pathologies of common bean accessions and to identify the one which is tolerant to these pathologies in medium altitude conditions of Tshilenge, in the Democratic Republic of Congo.

II. METHODOLOGICAL APPROACH

A. Study Environment

The study was conducted in the Kashila group, in the Tshilenge territory, in the Kasai Oriental province of the Democratic Republic of Congo. The geographic coordinates of the experimental site are: 06°26′49.62″ South latitude and 23°45′15.66″ East longitude at an altitude of 615 m (Garmin GPSMAP64, 2026).

According to the Koppen classification, the Tshilenge territory has a hot and humid tropical Aw3 climate, with alternating seasons: a long rainy season of 9 months from August 15 to May 15 and a dry season of 3 months from May 15 to August 15. Average annual rainfall is estimated at approximately 1200 mm to 1400 mm (Kambi, 2001).

The average annual temperature varies between 22°C and 25°C. The daytime temperature of the coldest month is above 18°C. Sunshine duration averages 10 hours and 45 minutes per year (Kambi, 2001). The soil of Kashila in the Tshilenge territory belongs to the ferralsol group (ferrallitic soil of the kaolisol type) (Mbuyi, 2012).

The Tshilenge territory remains dominated by plateaus with an average altitude ranging from 500 to 797 meters. These plateaus are deeply incised by a hydrographic network that has carved them into undulating formations. The area is characterized by moderate hills and shallow valleys, typical of the landscapes of Eastern Kasai (Kambi, 2001).

The vegetation consists of wooded grassland savanna, dominated by plant species such as: grasses (Imperata cylindrica, Bracharia mutica); asters (Commelina diffusa, Commelina bengaralensis); and legumes (Mimosa invisa) (Tshibamba et al., 2025).

The hydrographic network is comprised of two rivers: the Lubilanji River (locally called Tshilemba) and the Kalelu River. These two rivers receive water from streams, notably the Tshikalenga stream, which flows into the Tshilemba River, and the Muya stream, which flows into the Kalelu River (Kambi, 2001).

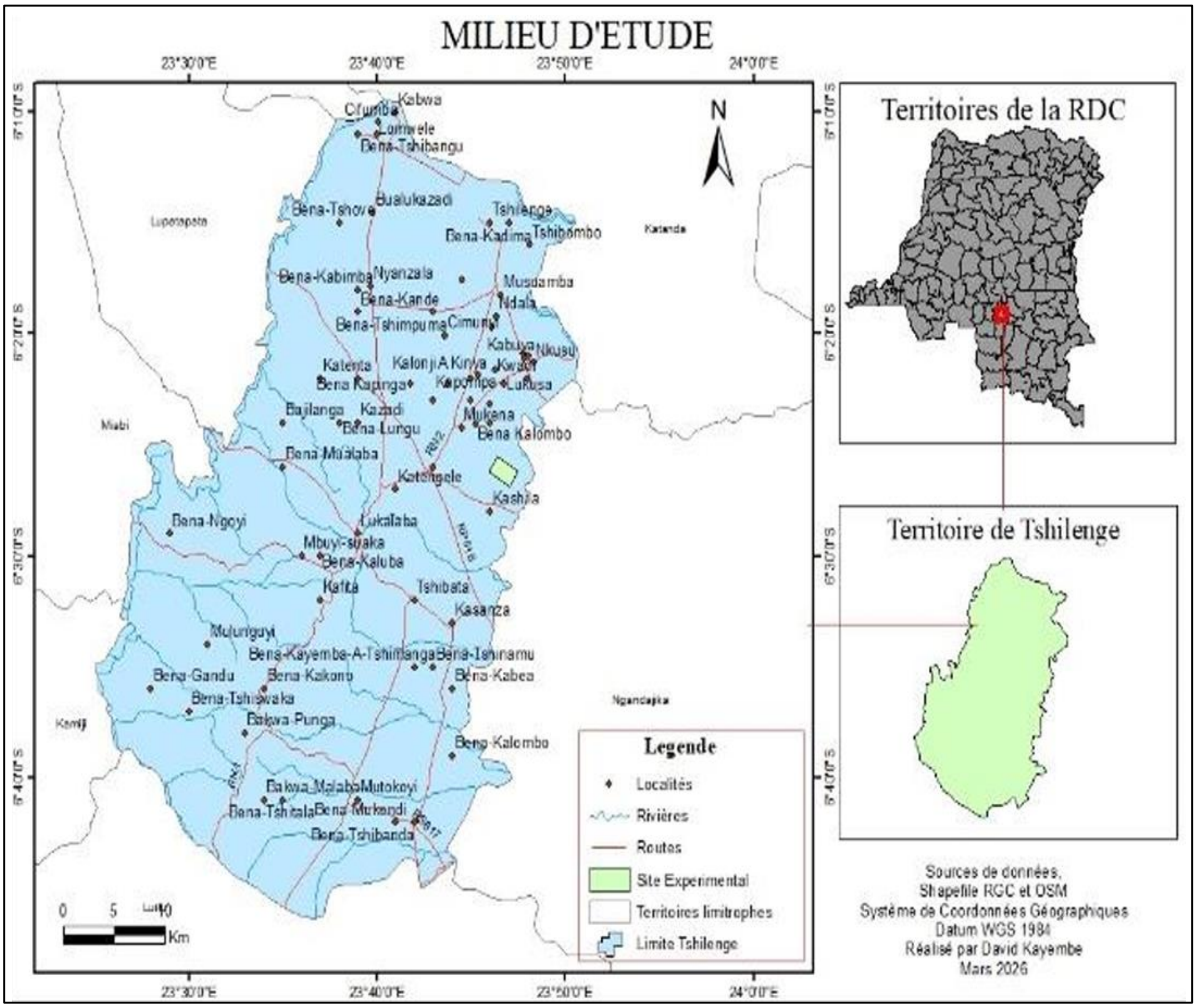

Fig 1 Location of the Kashila Experimental Site on the Administrative Map of the Tshilenge Territory.

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B. Material

➢ *Biological Materials*

The biological materials used in this study consist of four common bean accessions named according to their seed color, purchased on the local market; whose name and genetic origin are neither known nor documented.

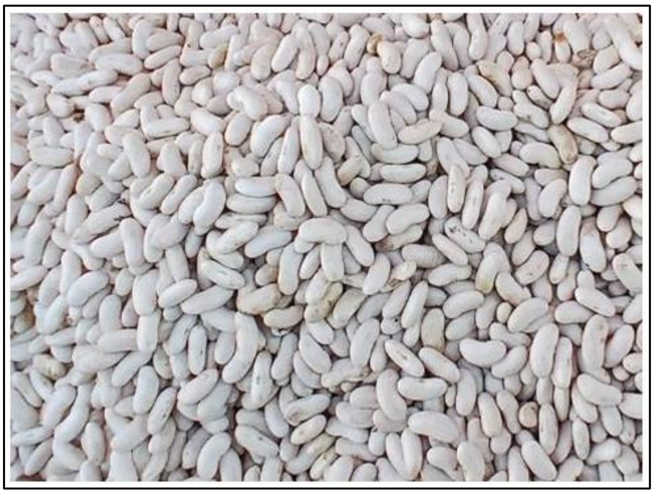

Fig 2 HC1: Common Bean with White Seeds

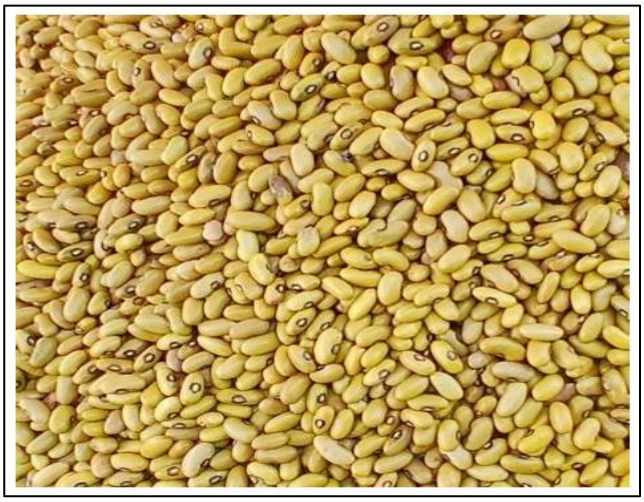

Fig 3 HC2: Common Bean with Light Yellow Seeds

Fig 4 HC3: Common Bean with Red-Speckled Seeds

Fig 5 HC4: Common Bean with Speckled White Seeds

C. Method

➢ *Experimental Setup*

A completely randomized experimental device for collecting data on fungal diseases of common bean was installed in the field with a single factor, which is the accession of common bean with 4 variants: HC1: common bean with white seeds, HC2: common bean with light yellow seeds, HC3: common bean with spotted red seeds and HC4: common bean with spotted white seeds.

The experimental field had a length of 17 m in length and 17 m in width, giving an area of 289 m2. It was divided into 4 repetitions or blocks, each block was in turn subdivided into 4 experimental plots, each plot measured 3 m in length and 3 m in width, i.e. an area of 9 m2 and represented an accession of common bean. The seeds were sown at spacings of 30 cm x 30 cm with 2 seeds per hole. Each plot had 10 lines and each line had 30 pockets.

➢ *Data Collection*

Only fungal diseases were assessed according to the symptoms of each on the organs of the central plants. The incidence of attack was evaluated using the following formula:

$$\text{Incidence of attack (\%)} = \frac{\sum(\text{Number of plants attacked})}{\text{Total number of plants in the experimental plot}} \text{ X } 100$$

III. RESULTS

Damping-off, angular leaf spot and cercospora leaf spot are the main fungal diseases identified on the four common bean accessions in this study.

➢ *Attack of Damping off*

Figure 6 below shows the incidence rate due to damping-off for local accessions of common bean (HC1, HC2, HC3 and HC4) under the pedoclimatic conditions of Kashila.

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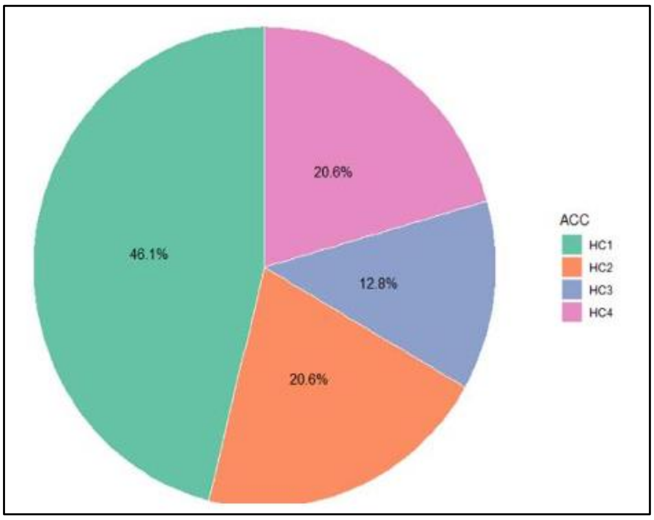

Fig 6 Incidence of Attack Due to Damping-off.

The attack rate levels linked to damping off vary greatly depending on the accessions. Some accessions show high sensitivity, while others have very low or even zero attack rates. Accession HC1 presents the highest values of damping off attack. This indicates a high susceptibility to damping off. Accession HC3 presents the lowest overall rates, which suggests good tolerance of this accession. Accession HC4 shows low to moderate damage, similar to HC3. Damage due to damping off remains generally low to moderate across all treatments.

➢ *Attack on Angular Spots*

The graph below shows the incidence rate of attacks due to angular leaf spot (ALS) in four local accessions of common bean (HC1, HC2, HC3 and HC4).

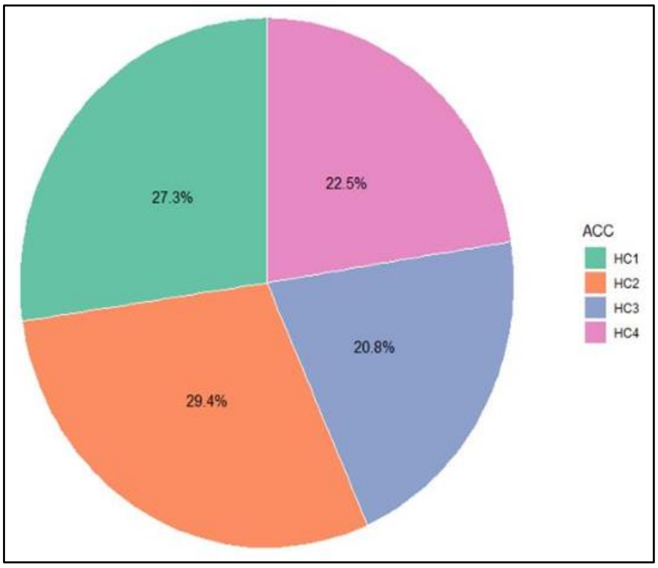

Fig 7 Incidence D'attaque Due Aux Taches Angulaires.

Attack rates related to angular spots vary considerably among accessions. Angular spots cause significant damage. Accession HC2 appears to be the most susceptible to angular spots. Accessions HC3 and HC4 generally exhibit the lowest damage levels, indicating greater tolerance.

➢ *Sigatoka Attack*

The graph below shows the incidence rate of attack due to cercospora leaf spot (AC) in four local accessions of common bean (HC1, HC2, HC3 and HC4).

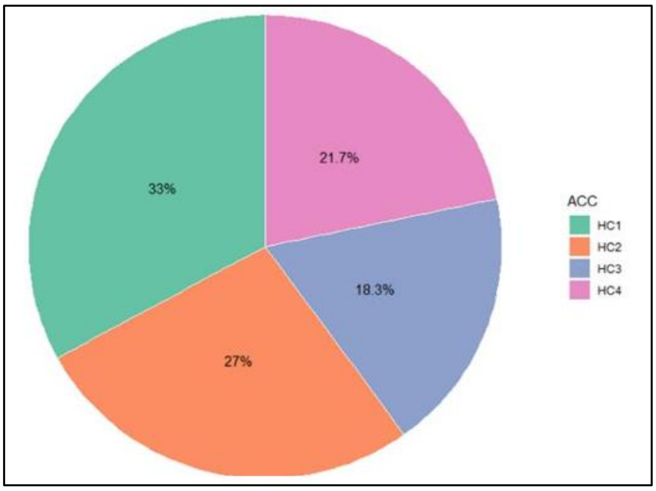

Fig 8 Incidence of Cercospora Leaf Spot Attack

Cercospora leaf spot infection rates vary considerably among accessions. Cercospora leaf spot causes significant damage. Accession HC1 appears to be the most susceptible to Cercospora leaf spot. Accessions HC3 and HC4 generally exhibit the lowest infection rates and seem more tolerant.

IV. DISCUSSION

The general trend observed in Figures 2, 3, 4 on the results of the main fungal diseases of the four common bean accessions under study highlights a significantly large variability in the incidence of damping-off, angular leaf spot and cercospora leaf spot.

These three identified diseases join a group of fungal diseases observed by Goudjo et al. (2023), who revealed that fungal diseases of green beans accounted for the majority at 70.26%, followed by viral diseases (16.66%) and bacterial diseases (13.07%), for which Africa represents 14.70% of the incidence rate. The authors emphasize that fungal diseases constitute the main category of diseases affecting green beans, a finding similar to that of Boussaber et al. (2012), who indicated that 83% of plant diseases are attributable to fungi.

Damping-off in common beans is a soilborne fungal disease (caused primarily by fungi such as Pythium or Rhizoctonia) that leads to seed rot before emergence or to seedling collapse at the crown (Delhove et al., 2023; Goudjo et al., 2023). Damping-off results in plant loss (Pythium sp.) or plant stunting and wilting (Fusarium sp., Thielaviopsis basicola, Rhizoctonia solani), with the presence of brown necrosis in the root system and at the crown (Morel et al., 2021).

Damming-off infection rates vary considerably among accessions. Some accessions show high susceptibility, while others exhibit very low or even zero infection rates. Furthermore, Epeko et al. (2024) observed no variation in the

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incidence of damping-off disease across common bean varieties. This could be explained by the very close sowing dates, as well as the resistance of improved and biofortified varieties used as experimental planting material. Angular leaf spot is a fungal disease caused by Phaeoisariopsis griseola (Sacc.) (syn: Pseudocercospora griseola), a fungus widely distributed in tropical areas. This disease is recognized as a serious fungal disease affecting beans in many regions. Infection with this fungus can lead to significant yield losses, reaching up to 80% in tropical and subtropical countries (Muthomi et al., 2011). According to Etana (2022), angular leaf spot is the most important disease affecting bean production in Africa. Angular leaf spot disease in common beans can be managed by using seeds from resistant varieties, and fungicide application can effectively control angular leaf spot (Paparu et al., 2014).

Cercospora leaf spot is a fungal disease caused by the fungus Cercospora sp. Fields severely affected by this disease can experience yield losses of up to 50%. Yield losses can range from 30% to 80% depending on the severity of the infestation, varietal susceptibility, and agroecological conditions (Pande et al., 2009).

Prophylactic measures are recommended, such as avoiding sprinkler irrigation, especially late in the day, using healthy seeds, removing leaves from infected plants, and promoting adequate ventilation in the field through optimal plant spacing (Berton, 2019).

V. CONCLUSION

This study reveals that damping-off, angular leaf spot, and cercospora leaf spot are the major fungal diseases identified on the four common bean accessions cultivated at mid-altitudes in Tshilenge, specifically in the village of Kashila in the Democratic Republic of Congo.

According to the results, the incidence of damping-off varies considerably among the accessions, allowing them to be grouped into three categories: HC1 is the most susceptible accession, HC3 is the most tolerant, and HC2 and HC4 are the most moderately susceptible.

For angular leaf spot, the incidence also varies among the common bean accessions, with HC2 and HC1 being the most susceptible, while HC4 and HC3 are the most moderately susceptible. Regarding the incidence of cercospora leaf spot, the infestation rate varies considerably depending on the accession. Accession HC1 is the most susceptible, while accession HC2 is moderately susceptible, and accessions HC3 and HC4 are tolerant.

Thus, accession HC3 is tolerant to damping-off, accessions HC4 and HC3 are moderately susceptible to angular leaf spot, and accessions HC3 and HC4 are tolerant to cercospora leaf spot. Their cultivation in production would require adherence to an agricultural calendar to reduce pest and pathogen pressure.

Given its tolerance to damping-off, angular leaf spot, and cercospora leaf spot, accession HC3 is recommended for common bean producers in the mid-altitude region of Tshilenge, Democratic Republic of Congo, provided the agricultural calendar is followed.

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