OPEN ACCESS Plant Protection, 09 (03) 2025. 549-559 DOI:10.33804/pp.009.03.5621

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Available Online at EScience Press

Plant Protection

ISSN: 2617-1287 (Online), 2617-1279 (Print)

http://esciencepress.net/journals/PP

Research Article

Assessment of Incidence, Severity and Farmers' Perceptions of Peanut Rust in Rural Areas of Burkina Faso

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ARTICLE INFO

Article history

Received: 6th March, 2025

Revised: 15th July, 2025

Accepted: 5th August, 2025

Keywords

Peanut rust

Disease incidence

Farmers' perceptions

Burkina Faso

Puccinia arachidis

ABSTRACT

This study investigated the socio-demographic characteristics of peanut producers and their cropping practices in relation to peanut rust incidence and management across three regions in Burkina Faso. Among the 120 surveyed producers, 62.22% were women, indicating a significant predominance of female involvement ($p < 0.001$). Educational levels were notably low, with 67.77% being illiterate, which was statistically significant ($p < 0.001$). This limited literacy was found to influence the management of peanut rust, emphasizing the importance of education in disease control strategies. In terms of cropping practices, monoculture was most common (45.55%), followed by crop rotation (31.86%) and intercropping (21.97%). These differences were significant ($p < 0.001$), and logistic regression revealed that crop rotation significantly reduced rust incidence compared to monoculture and intercropping ($p = 0.0116$). Furthermore, 90.1% of producers relied on local (non-certified) seeds, a factor likely contributing to disease spread due to lack of quality control ($p < 0.001$). Although 93.73% of producers recognized rust symptoms, misconceptions about its cause were widespread. Only 25.09% correctly identified rust as a disease, while 56.39% perceived it as a sign of peanut maturity, and 18.51% were unsure, with the distribution being statistically significant ($p < 0.001$). Rust incidence and severity remained high across regions (≥70%), with significant variability among localities ($p < 2e\text{-}16$), though a slight overall decline was noted between 2022 and 2023. In conclusion, enhancing education, promoting crop rotation, and improving access to certified seeds are essential strategies for reducing rust impact and improving peanut production in Burkina Faso.

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Introduction

Peanut (*Arachis hypogaea* L.) is cultivated throughout the intertropical zone (Schilling et al., 1996) and ranks fifth among the world's oilseed crops, following palm oil, soybean, rapeseed, and sunflower (FAO, 2022). It is a key crop for both domestic consumption and international trade (Christie et al., 2015). In 2021, global peanut production reached 53.93 million tons from a harvested area of 32.72 million hectares; with an average yield of 1,648.1 Kg/ha (FAOSTAT, 2022).

In Burkina Faso, peanut is grown in all regions and is considered one of the most important cash crops (MAAH,

2020). The peanut sector has historically been a cornerstone of the national economy, providing farmers with both food security and income (Sawadogo, 2020). In 2022, peanut production in Burkina Faso was estimated at 559,064.4 tons from 623,769 hectares, corresponding to a national average yield of 896.3 Kg/ha (FAOSTAT, 2024). Beyond its role as a cash crop, peanut is essential for food security, particularly in the semi-arid regions of the country, where it often serves as the primary oilseed crop (Ouédraogo et al., 2014).

However, peanut production faces numerous challenges, including biotic stresses. Among these, peanut rust, caused by *Puccinia arachidis* Speg., is one of the most destructive diseases in peanut-growing regions (Mondal and Badigannavar, 2015). Along with leaf spot, peanut rust can result in yield losses of up to 70%. The disease is characterized by the appearance of lesions on the leaves, leading to reduced photosynthetic activity, impaired plant growth, and significant yield reduction (Taita et al., 1996).

Recent studies by Koita et al. (2012) and Nana et al. (2023) have identified peanut rust as one of the most damaging foliar diseases of peanut in Burkina Faso. Although a 1984 survey reported rust occurrence across four agro-ecological zones in the country, from the southwest to the north, with the highest severity observed in the southwest (Sankara, 1997), the current impact of the disease in rural areas remains poorly documented. Moreover, there is a lack of information regarding farmers' awareness and perceptions of peanut rust, including its causes, symptoms, impact on yield, and the management practices they employ.

Updated data on disease prevalence in farmers' fields, along with an assessment of farmers' perceptions and the effectiveness of existing control measures, are crucial for developing appropriate and sustainable management strategies. Therefore, the objective of this study was to assess the prevalence and severity of peanut rust in the field and to document farmers' perceptions of the disease and their current management practices.

Materials and Methods

Study area

The study was conducted across 12 localities in three regions of Burkina Faso: the Hauts-Bassins (Bodialidaga, Nasso, Desso, Karangasso-Sambla), Centre-East (Bagré, Kalmodo, Louanga, Pata), and Centre (Koubri, Koala, Gampèla, Tabtenga) (Figure 1). These regions were selected based on their agro-climatic diversity and their significance in peanut production. The Hauts-Bassins region lies within the Sudanian zone, while the Centre and Centre-East regions are situated in the Sudano-Sahelian zone. This geographical distribution allows for the assessment of climatic influences on the incidence and distribution of peanut rust.

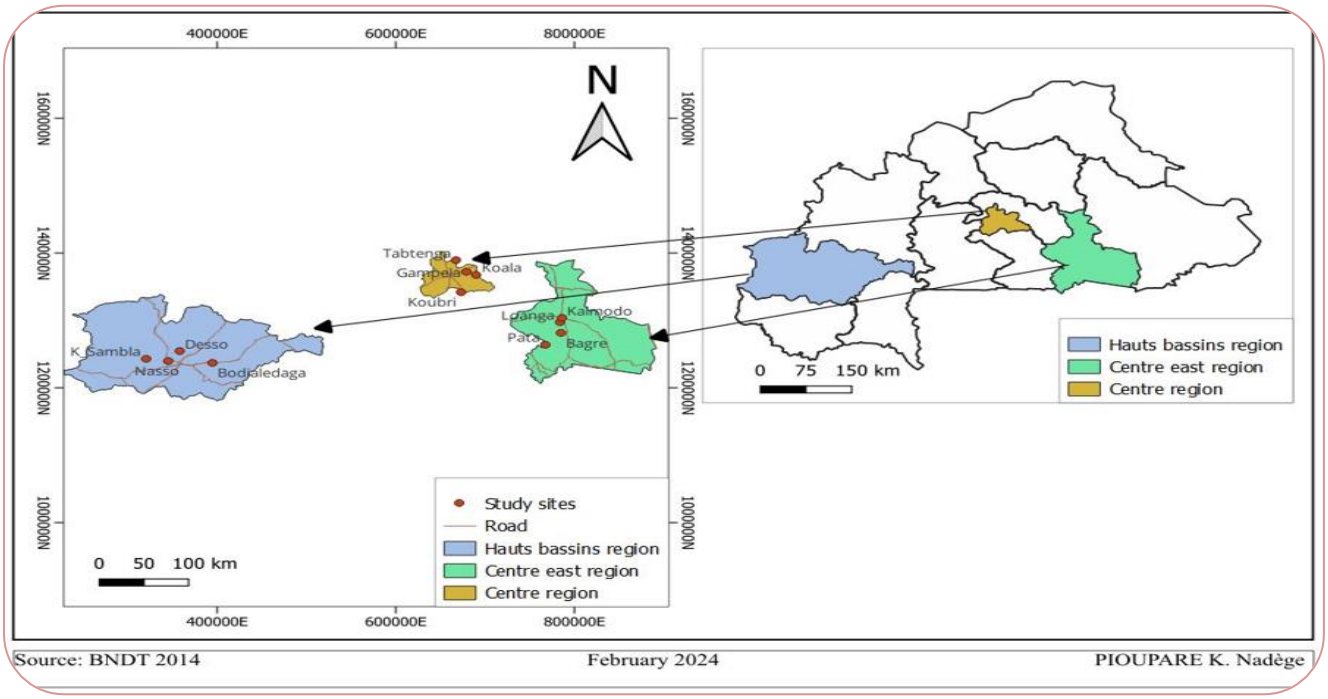

Figure 1. Locations of the study sites.

Site selection was carried out in collaboration with regional agricultural authorities, considering crop availability, production levels, and phytosanitary history. The Sudanian zone, located south of parallel 11°30′ N, receives an average annual rainfall ranging from 900 to 1,200 mm, with a rainy season lasting approximately six months. In contrast, the Sudano-Sahelian zone, situated between latitudes 11°30′ and 14°00′ N, receives between 600 and 900 mm of annual rainfall, typically concentrated over a four- to five-month period (Ouedraogo et al., 2010).

Survey method

Surveys were conducted during two periods, August to September 2022 and August to September 2023, using a structured questionnaire administered to peanut producers. The questionnaire covered socio-demographic variables (e.g., sex, education level), seed sources, cultural practices, and farmers' knowledge of peanut rust, particularly symptom recognition and understanding of symptom causes. This methodology generated essential data for understanding disease management practices and control strategies employed by farmers. The survey targeted peanut producers across three agricultural regions in Burkina Faso: Hauts-Bassins, Centre-Est, and Centre. In each region, four localities were selected, and ten producers were surveyed per locality, totaling forty producers per region.

The distribution of respondents was determined in consultation with the technical services of the Ministry of Agriculture, based on the actual structure of peanut production at the regional level. This approach ensured a representative sample of the target population. All selected producers were adults who met strict inclusion criteria, including at least three years of experience in peanut cultivation, availability during the survey period and free and informed consent to participate.

Survey and disease assessment method

Plot selection and sampling method

The survey aimed to collect data on the occurrence and impact of peanut rust. In each locality, three representative fields were selected based on criteria such as accessibility, cultivated area, phenological stage, field spacing, and the availability of the farmer. Each selected field had a minimum area of 5,000 m^2 to ensure adequate representativeness. To reduce bias from spatial proximity and potential pathogen dispersal, a minimum distance of 1 Km between fields was maintained. Surveys were conducted at the post-flowering phenological stage, which is optimal for symptom observation. In total, 36 fields were surveyed. Within each field, four quadrats (2 m × 1 m each) were used for disease assessment, following the method described by Rahetlah et al. (2013).

Assessment of disease incidence and severity

Peanut rust incidence was assessed by counting the number of symptomatic and asymptomatic plants within each quadrat, along with the total number of plants. Incidence was calculated using the formula provided by Le Poivre (2003):

$$\% \text{ Incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Disease severity was assessed on ten randomly selected peanut plants per quadrat using a 1-to-9 rating scale, where: 1 = 0%, 2 = 1-5%, 3 = 6-10%, 4 = 11-20%, 5 = 21-30%, 6 = 31-40%, 7 = 41-60%, 8 = 61-80%, 9 = 81-100%, as described by Subrahmanyam et al. (1995). Severity was calculated using the formula by Kumhar et al. (2018):

$$\% \text{ Severity} = \frac{\sum n}{N \times 9} \times 100$$

Where:

Σn = sum of individual severity scores,

N = total number of plants assessed,

9 = maximum score on the severity scale

Data processing

All statistical analyses were performed using R software (R Development Core Team, 2018), version 4.2.3. Socio-demographic data collected from farmers were used to calculate proportions using the formula:

$$P\ (\%) = \frac{n}{N} \times 100$$

Where:

P = proportion

n = number of cases

N = total number of respondents

Field data were used to calculate incidence and severity for each site and region using above-mentioned formulae. Differences in proportions, incidence, and severity were analyzed using the Chi-square test applied to contingency tables, as described by Ouattara et al. (2024).

Results

Producer profile based on gender and educational attainment

A total of 120 peanut producers were surveyed, of whom 62.22% were women and 37.77% were men, yielding a female-to-male ratio of 1.64. A proportion test indicated that this gender difference was statistically significant ($p <$

0.001), confirming the predominance of women in peanut production. Regarding educational attainment, the majority of producers were illiterate (67.77%), while 32% had primary education and only 2.22% had secondary education (Figure 2). A chi-square test comparing these proportions to an equal distribution revealed a highly significant difference ($p < 0.001$), emphasizing the high illiteracy rate among the surveyed producers.

These results indicated a greater involvement of women in peanut production compared to men. Furthermore, analysis of the data revealed that the level of education significantly influences the management of peanut rust, emphasizing the critical role of education in the adoption of effective disease management practices. Enhancing access to education could improve producers' knowledge and ability to implement appropriate phytosanitary measures, thereby reducing the incidence and impact of rust and other fungal pathogens.

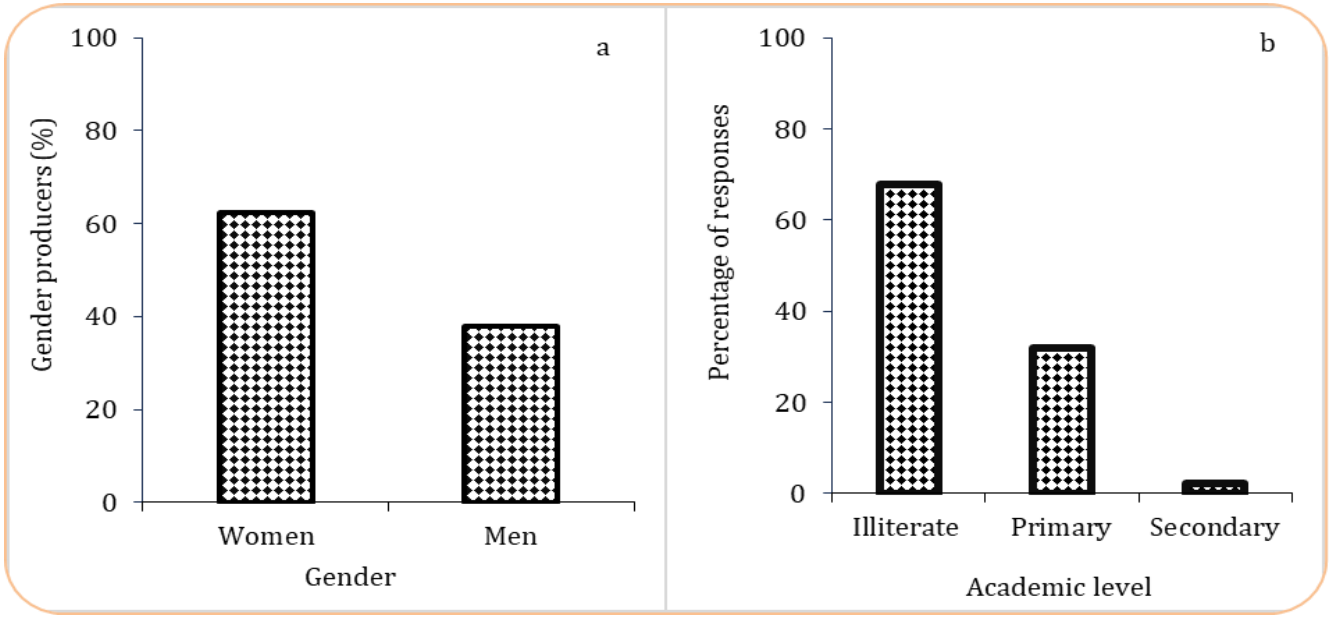

Figure 2. Distribution of peanut producers by (a) gender and (b) educational attainment.

Description of producers based on cropping practices and seed source

Survey results on peanut cultivation indicated that 45.55% of producers practiced monoculture, while 31.86% and 21.97% adopted crop rotation and intercropping, respectively. Statistical analysis of cropping practices revealed a significant difference among these categories ($\chi^2 = 10.706$, df = 2, $p < 0.001$), suggesting that monoculture was more frequently practiced than other systems.

With regard to seed source, the majority of producers (90.1%) used local (non-certified) seeds, whereas only 8.79% used certified seeds (Figure 3). A test of proportions comparing these groups yielded a highly significant result ($\chi^2 = 153.61$, $p < 0.001$), confirming a strong predominance of local seed use in groundnut production.

The widespread use of local seed, often lacking quality control, may contribute to the dissemination of peanut rust, highlighting a critical factor for consideration in plant health management. These cropping practices and seed choices have important implications for the effective management of rust disease in peanut cultivation.

Distribution of producers surveyed on the recognition of rust symptoms

The survey results showed that 89.5% of producers in the Centre region were well-informed about peanut rust, with even higher awareness levels in the Centre-East (97%) and Hauts-Bassins (94.7%) regions. These figures indicated a high level of recognition of this major fungal disease, particularly its characteristic symptoms such as orange pustules on leaves and stems. Overall, across the three regions, 93.73% of producers demonstrated accurate knowledge of rust symptoms (Figure 4). This widespread awareness is likely attributed to frequent exposure to peanut rust in these areas. The recognition rate was statistically significant ($P < 0.001$), confirming that the majority of producers can reliably identify the symptoms of rust.

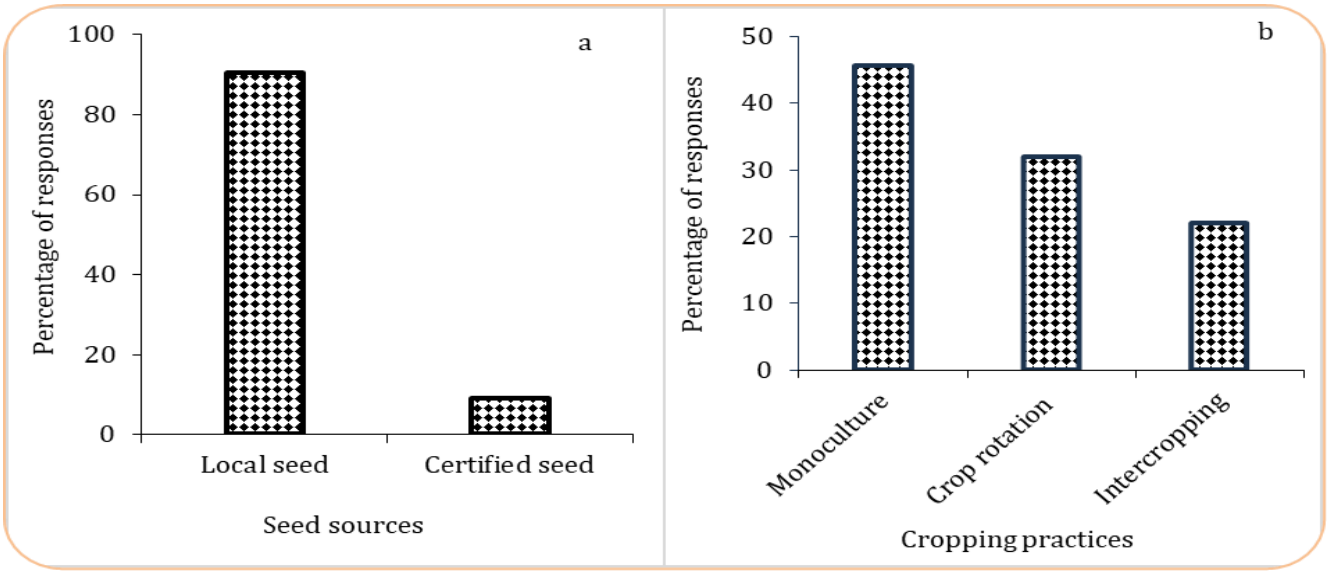

Figure 3. Distribution of peanut producers by (a) seed source preferences and (b) cropping pratices.

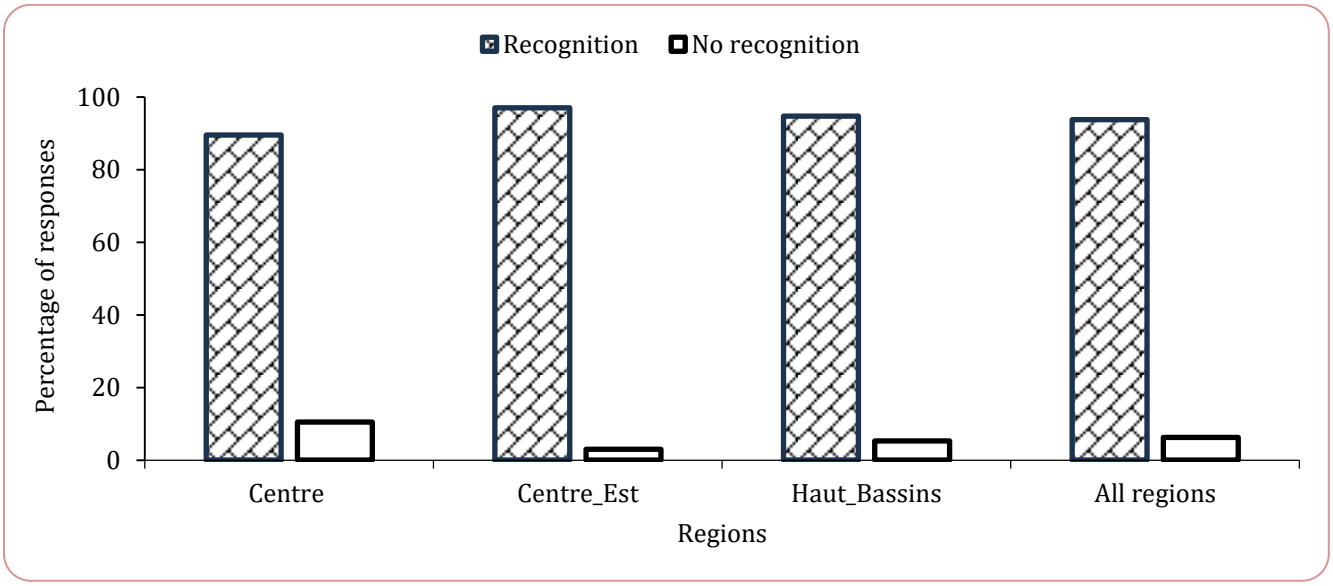

Figure 4. Distribution of peanut producers based on their ability to recognize disease symptoms.

Causes of characteristic rust symptoms according to surveyed producers

The survey results revealed varied perceptions among producers regarding peanut rust. Only 26.31% of producers in the Centre region considered rust to be a disease, compared to 12.12% in the Centre-East and 36.84% in the Hauts-Bassins region. In contrast, the majority of producers perceived rust as an indicator of peanut maturity, with 53.69% in the Centre, 70.93% in the Centre-East, and 44.56% in the Hauts-Bassins expressing this view. Furthermore, a notable proportion of producers, 20%, 16.95%, and 18.6% in the respective regions, believed that rust was neither a disease nor an indicator of maturity (Figure 5).

When the average perceptions across the three regions were evaluated, 25.09% of producers considered rust to be a disease, 56.39% perceived it as an indicator of peanut maturity, and 18.51% believed it was neither a disease nor an indicator of maturity. Statistical analysis using the chi-square test ($p < 0.001$) indicated that these proportions differed significantly from an equal distribution among the three categories. This confirmed that the perception of rust as an indicator of maturity was statistically dominant among the surveyed farmers.

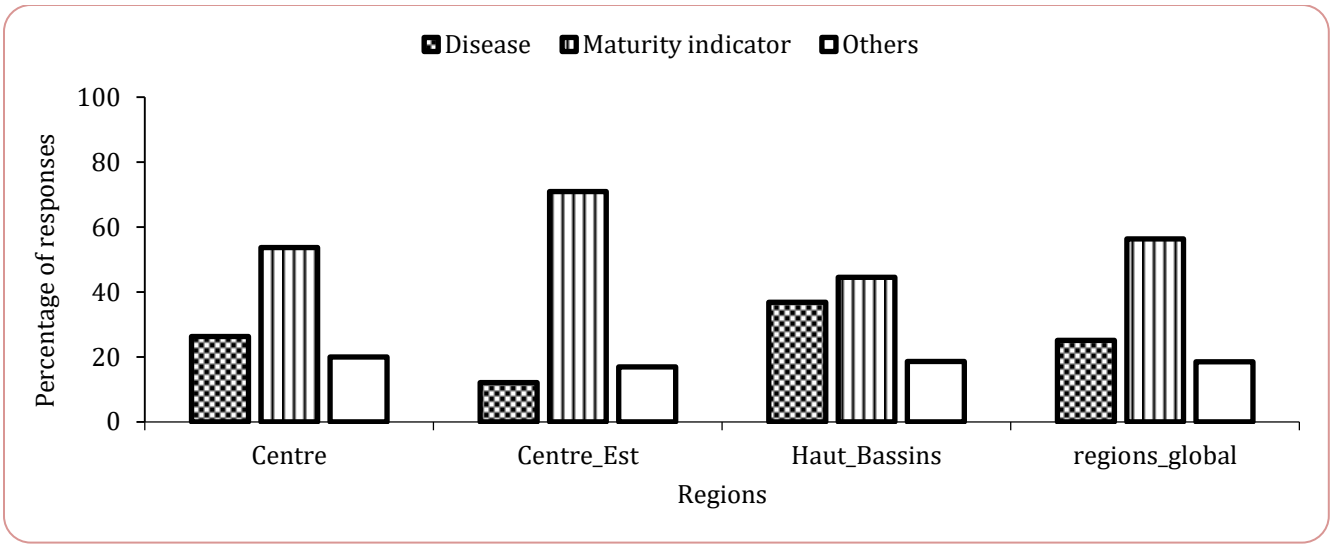

Figure 5. Distribution of farmers surveyed based on their recognition of disease symptoms.

Influence of cropping practices on rust occurrence

Logistic regression was employed to assess the effect of cropping practices on the occurrence of peanut rust in the surveyed plots. The contingency table (Table 1) indicated a higher disease frequency under monoculture (61.8%) and intercropping (66.7%) compared to crop rotation (26.3%). The adjusted logistic regression model was statistically significant (p = 0.0116), suggesting that cropping practice was a significant explanatory variable for rust occurrence (Table 1). Figure 6 depicts the distribution of rust presence and absence across different cropping practices, showing a higher frequency of the disease in the absence of crop rotation.

Table 1. Contingency table showing the distribution of cropping practices.

Cropping practice	% Rust	Odds Ratio (IC 95 %)	P-value
Crop rotation	26,3 %	-	-
Monoculture	61,8 %	4,76 [1,47-15,42]	0,0095
Intercroping	66,7 %	6,00 [1,39-25,97]	0,0173

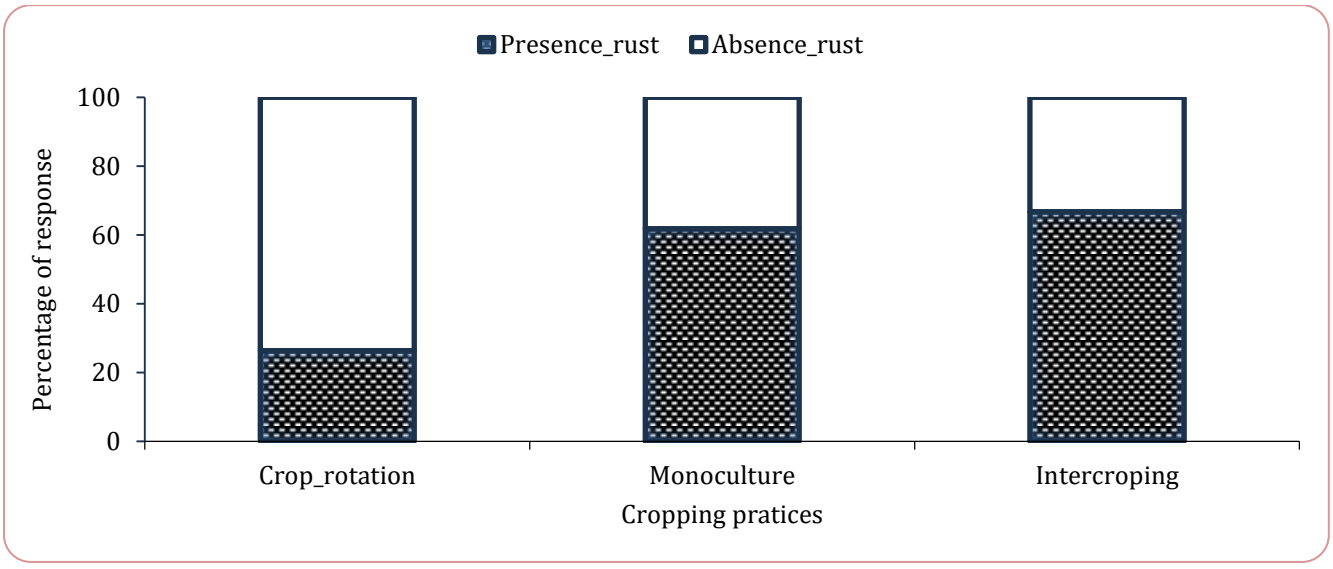

Figure 6. Distribution of rust presence and absence in relation to cropping practices.

Incidence and severity of rust in the field

The incidence rates ranged from 80.05% to 71.69% in 2022 and from 81.80% to 78.33% in 2023 (Figure 7). Statistical analysis showed no significant differences in incidence rates among the regions in either year (P = 0.218 and P = 0.594). The severity rates ranged from 69.07% to 58.00% in 2022 and from 75.00% to 69.42% in 2023. Similarly, no significant differences in severity rates were observed for either year (P = 0.085 and P = 0.269). However, differences were observed between localities within the same region. Over the two evaluation years, the locality of Pata in the Centre-East region consistently exhibited the highest incidence and severity rates, while the lowest rates were recorded in the locality of Kalmodo within the same region in 2022 (Table 2). Statistical analysis revealed a significant difference in prevalence and severity rates among the localities ($p < 2e\text{-}16$ ***). A similar trend was observed in 2023 (Table 3). In the Hauts-Bassins region, the localities of Bodialidaga and Nasso recorded the highest prevalence and severity rates from 2022 to 2023, with a significant difference detected ($p < 2e\text{-}16$ ***). In the Centre region, the localities of Koala and Tabtenga exhibited the highest prevalence and severity rates during the same period, and the difference was also statistically significant ($p < 2e\text{-}16$ ***). Overall, a general decline in severity and incidence rates was observed over the two years of monitoring.

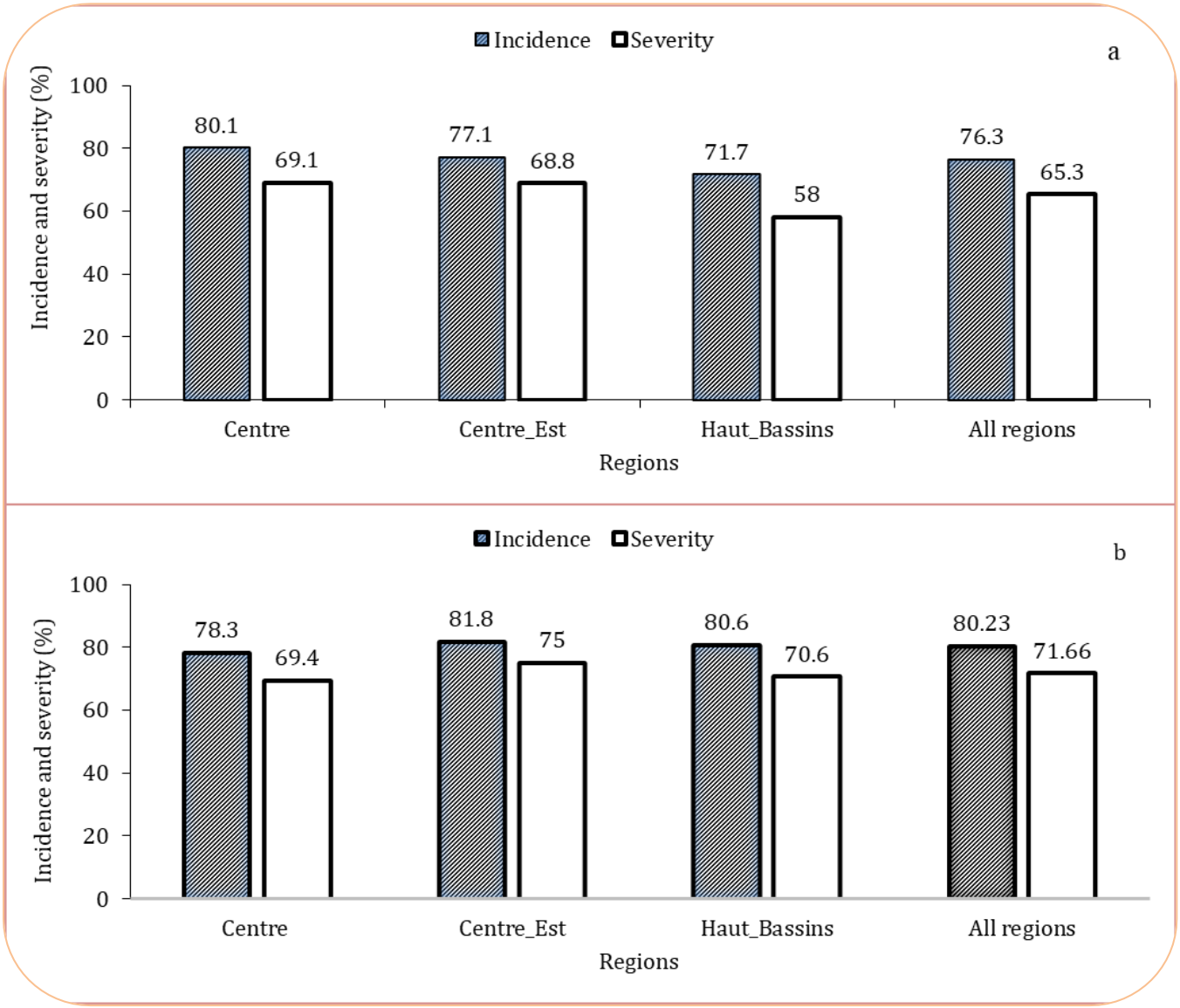

Figure 7. Incidence and severity rates of peanut rust in 2022 (a) and 2023 (b).

Table 2. Incidence and severity of peanut rust by area in 2022.

Regions	Localities	Incidence %	Severity %
Centre_Est	Pata	97.44 ± 2.46 a	92.77 ± 3.85 a
	Loanga	93.88± 6.03 ab	86.51± 6.31 ab
	Bagré	77.8 ± 5.53 cd	68.14 ± 9.48 c
	Kalmodo	39.22 ± 8.83 g	27.77 ± 6.78 e
Haut_Bassins	Bodialidaga	93.55 ± 6.04 ab	86.29 ± 5.83 ab
	Nasso	87.22± 6.98 abc	81.03 ± 8.54 b
	Karangasso Sambla	58.66 ± 8.89 e	31.22 ± 8.17 e
	Desso	47.33 ± 13.8 f	33.45 ±7.26 e
Centre	Koala	95.22± 4.87 ab	87.72 ± 7.62 ab
	Tabtenga	85.22± 9.15 bc	72.51 ± 7.66 c
	Gampèla	74.44± 11.0 d	64.45 ± 9.58 c
	Koubri	65.33 ± 11.5 e	51.60 ± 13.8 d
P-Value		<2e-16 ***	

Table 3. Incidence and severity of peanut rust by area in 2023.

Regions	Localities	Incidence %	Severity %
Centre_Est	Pata	97.22 ± 2.22 a	91.46± 3.93 a
	Loanga	90.00 ± 4.58 ab	84.73 ±3.34 ab
	Bagré	87.88 ± 6.51 b	77.03± 2.15 b
	Kalmodo	52.11± 6.75 e	46.78 ± 9.47 e
Hauts_Bassins	Bodialidaga	91.00 ± 5.87 ab	80.76 ± 4.95 b
	Nasso	89.44 ± 7.63 ab	84.70 ± 7.71 ab
	Karangasso Sambla	76.66 ± 6.67 c	63.45 ± 7.61 c
	Desso	65.33±5.85 d	53.45 ± 6.89 de
Centre	Tabtenga	88.44 ± 5.43 b	77.52 ± 7.65 b
	Koala	87.33 ± 2 b	78.83 ± 3.31 b
	Koubri	69.66 ± 8.85 d	59.13 ± 13.6 cd
	Gampèla	67.88 ± 11.6 d	62.21 ± 10.9 c
P-Value		<2e-16 ***	

Discussion

This study highlights peanut rust as a major phytopathological constraint to peanut production in Burkina Faso. The findings indicate that the majority of peanut producers are women, which may be attributed to their greater involvement in this crop, likely due to socio-economic and cultural factors such as limited access to land and productive resources. Ouédraogo et al. (2014) also reported that women are predominantly responsible for tasks related to peanut cultivation. These findings are consistent with those of Koné et al. (2019) in Côte d'Ivoire, where 85% of peanut producers are women. This parallel between Burkina Faso and Côte d'Ivoire suggests that the roles and challenges faced by women in peanut production are broadly shared across the West African region.

Despite their predominance in peanut farming, women face numerous challenges in accessing essential resources for production. These include limited access to land, fungicides, agricultural inputs, and decision-making authority, all of which increase their vulnerability to crop diseases (FAO, 2011).

The survey also reveals that most producers are illiterate, posing a significant barrier to the effective implementation of disease management strategies. This underscores the urgent need for more accessible and appropriate agricultural extension services. Diouf et al. (2016) and Traoré et al. (2019) observed that producers with low literacy levels are less likely to adopt

sustainable practices or use plant protection products, thereby exacerbating the spread and impact of diseases such as peanut rust. A lack of education and training continues to hinder effective disease control, despite the high disease prevalence in certain regions.

However, low literacy is not the sole factor limiting the adoption of control measures. In many rural areas of Burkina Faso, the number of agricultural extension agents is insufficient, and those available often lack specialized training in plant pathology. This weak extension system further limits knowledge transfer regarding diseases like rust (Sawadogo et al., 2022), contributing to the persistence of ineffective farming practices.

Furthermore, most producers prefer using local seeds over certified varieties, primarily due to economic constraints and limited availability of certified seed. Although local seeds are more accessible, they may contribute to disease spread, as they often lack phytosanitary treatment and quality assurance. Raising awareness among farmers about the long-term benefits of certified, disease-resistant seed is crucial. The low availability and high cost of certified seeds, combined with the belief that they offer no immediate advantages, partially explain the continued reliance on local seed. These findings highlight the urgent need to improve access to high-quality, disease-resistant seed varieties.

Peanut monoculture is another significant factor in the spread of peanut rust. Although this practice may provide short-term economic gains, it promotes the accumulation of pathogens such as *Puccinia arachidis* in the soil. This supports the agronomic hypothesis that repeated cultivation of the same host crop favors the establishment and persistence of inoculum. Sankara et al. (2013) noted that monoculture increases pathogen pressure, complicating disease management by facilitating continuous pathogen propagation. The survey shows that 56.39% of producers perceive peanut rust as an indicator of plant maturity, while only 25.09% recognize it as a disease. This misconception emphasizes a significant lack of awareness regarding the pathogenic nature of rust, which may hinder timely detection and integrated disease management. Misinterpreting rust symptoms can delay the application of control measures, aggravating disease severity.

Peanut rust, a fungal disease, can severely reduce yields and compromise seed quality. However, as demonstrated in this study, many producers fail to recognize it as a serious threat. This lack of recognition prevents the adoption of effective strategies such as fungicide use and cultivation of resistant varieties. Such knowledge gaps are well-documented in the literature. For instance, Sankara et al. (2013) found that producers in Burkina Faso, due to limited education and lack of training, often struggled to identify disease symptoms, which hindered timely intervention. Similarly, Ouédraogo et al. (2014) observed that some producers confused rust symptoms with natural signs of plant maturation, delaying effective phytosanitary responses.

The absence of adequate training in plant disease management and good agricultural practices has also been reported in Senegal by Diouf et al. (2020), who emphasized that this leads to poor management of peanut rust. Without sufficient knowledge and training, farmers are unlikely to adopt appropriate measures, such as using resistant varieties or fungicides, which facilitates the continued spread of the disease and increases yield losses. Traoré et al. (2019) also identified the lack of disease awareness and technical training as major barriers to the adoption of modern agricultural practices.

The survey results, which show a high incidence and severity of peanut rust in the Centre-East, Centre, and Hauts-Bassins regions, confirm the significant threat posed by this disease to peanut production. Sankara et al. (2013) noted that the hot and humid conditions in these regions during the rainy season are conducive to the development and spread of *P. arachidis*. High temperatures and humidity favor spore germination and dispersal, complicating disease control. Bandyopadhyay et al. (2016) corroborated these findings, indicating that peanut rust is more prevalent in regions where temperatures exceed 25°C and rainfall is abundant. Ouédraogo et al. (2014) also reported that poor agricultural practices, such as monoculture and lack of crop rotation, further contribute to pathogen persistence in the soil.

Furthermore, Traoré et al. (2019) highlighted that the lack of training and awareness among farmers remains a critical constraint to fungal disease management. Poorly informed producers often fail to adopt effective measures, resulting in greater disease severity. Diouf et al. (2020) also emphasized that the absence of integrated disease management strategies leads to significant yield losses, compromising both regional food security and farmers' livelihoods.

In summary, the high incidence and severity of peanut rust in the Centre-East, Centre, and Hauts-Bassins regions of Burkina Faso can be attributed to a

combination of favorable climatic conditions, unsustainable agronomic practices, and insufficient phytosanitary management. These findings highlight the need to intensify training efforts, enhance access to resistant varieties, and promote sustainable practices such as crop rotation to reduce the disease's spread and mitigate its impact. However, this study has certain limitations, including incomplete geographic coverage and reliance on self-reported data. Moreover, economic, institutional, and gender dimensions were not deeply explored, and cultural perceptions influencing disease management practices were not sufficiently analyzed. These limitations call for more comprehensive and interdisciplinary approaches in future research.

Conclusion

This study contributes significantly to understanding the prevalence and impact of peanut rust, emphasizing the urgent need for integrated disease management approaches. Peanut rust represents a serious threat to peanut production and quality in Burkina Faso, particularly in the Centre, Centre-East, and Hauts-Bassins regions. The survey results revealed an average incidence of 80.23% and an average severity of 71.66%, underscoring the disease's critical impact.

Improving farmers' knowledge of sustainable agricultural practices, including crop rotation, the use of resistant varieties, and early disease detection, is essential to limit disease spread and safeguard yields. Moreover, the implementation of effective management strategies, such as fungicide application and use of certified resistant seeds, is vital to reducing yield losses and maintaining product quality.

The findings highlight the importance of collaboration between research institutions, extension services, and farming communities to promote training and awareness programs focused on integrated disease management. Agricultural policies must facilitate access to inputs and improved seeds while supporting participatory research efforts to develop locally adapted solutions. Future research should also assess the long-term effectiveness of integrated management strategies, incorporating agronomic, biological, and genetic approaches.

Acknowledgements

We express our sincere gratitude to FONER for its essential financial support. We also thank Mr. Mohamed Sana of Joseph KI-ZERBO University for his meticulous proofreading of the manuscript and his valuable linguistic input, which significantly enhanced the quality of this work.

Authors' Contributions

KNP carried out the fieldwork, organized the data and drafted the manuscript; TAN designed and supervised the study, reviewed the manuscript; KHS participated in data analysis and reviewed the manuscript; DK and HS carried out the fieldwork; AO participated in the statistical analysis of the data and KK designed and supervised the study.

Research Funding

This research was made possible through generous funding from the Fonds National pour l'Éducation et la Recherche (FONER) in Burkina Faso.

Conflict of Interest

The authors declare no conflict of interest.

Sustainable Development Goals Targeted

SDG 2: Zero Hunger
SDG 3: Good Health and Well-being
SDG 13: Climate Action

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