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RESEARCH ARTICLE

FIELD-BASED EVALUATION OF SORGHUM FOR RESISTANCE TO STRIGA HERMONTHICA UNDER NATURAL INFESTATION

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ABSTRACT

Striga hermonthica is one of the most severe biotic constraints to sorghum production in sub-Saharan Africa, particularly under smallholder farming systems where control options are limited. Host plant resistance remains a key component of sustainable *Striga* management; however, resistance expression is often influenced by environmental conditions. This study evaluated the agronomic performance and *Striga* response of six sorghum varieties under natural infestation conditions in southern Niger over two rainy seasons. Four varieties known to be susceptible (*El_Tsédaoua*, *Mota Maradi*, *MR732*, and *Sepon82*) and two resistant checks (*N13* and *SRN39*) were assessed in a randomized complete block design with three replications. Data were collected on days to flowering, plant height, days to *Striga* emergence, and *Striga* density at 45, 60, and 90 days after sowing (DAS). Analysis of variance revealed significant genotypic effects for all traits measured, with year and genotype × year interactions observed for several *Striga*-related traits. Resistant varieties consistently delayed *Striga* emergence and maintained lower parasite densities throughout the cropping cycle compared with susceptible varieties. *Striga* density increased with crop age across all genotypes, although the magnitude of infestation differed markedly among varieties and between seasons. The results highlight substantial variation among the varieties in their response to *Striga hermonthica* under field conditions and confirm the importance of multi-year evaluation for reliable identification of resistance. This study provides valuable genetic resources for sorghum improvement screening and deployment in *Striga*-prone environments of the Sahel.

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INTRODUCTION

Smallholder farming systems in sub-Saharan Africa (SSA) are predominantly reliant on low-input cereal production, where productivity is severely limited by biotic and abiotic stresses. Sorghum (*Sorghum bicolor* [L.] Moench) is a staple crop in semi-arid regions, used as a source of food, feed, and income for millions of households (Kane et al., 2022). Over the past decades, national and international breeding programs have developed improved sorghum varieties with enhanced yield potential, stability, and stress tolerance. These efforts, often led by National Agricultural Research Systems (NARS) in collaboration with international institutions, have resulted in the release of both newly bred varieties and improved local landraces (FAO, 2025; MAGEL, 2025). Among biotic constraints, *Striga hermonthica* (Del.) Benth. is one of the most devastating parasitic weeds affecting cereal production in SSA. The parasite thrives across diverse agro-ecological zones, and its germination is triggered by strigolactones exuded by host roots, leading to haustorial attachment and severe nutrient and water diversion (Parker, 2012; Jamil et al., 2021). The persistent seed bank of *Striga*, combined with high seed production and long viability, makes it particularly challenging to manage in low-input systems (Rodenburg et al., 2015). Although agronomic practices such as hand weeding, intercropping, and fertilizer microdosing are employed, they often provide limited and unsustainable control on their own (Kanampiu et al., 2018).

Host plant resistance remains a cornerstone and cost-effective strategy for integrated *Striga* management. Recent advances have identified specific genes and mechanisms, such as *LOW GERMINATION STIMULANT 1 (LGS1)*, which reduces strigolactone exudation, providing a clear genetic basis for resistance (Gobena et al., 2017). However, the expression of resistance is highly genotype-by-environment dependent, necessitating multi-year and multi-location evaluations under natural infestation (Mohemed et al., 2016; Belay, 2018). Despite these advances, the adoption of improved varieties remains limited in many smallholder farming systems (Parker, 2012; Ndjeunga et al., 2015; Walker & Alwang, 2015). A key reason is that varieties developed under controlled research-station conditions may not perform consistently in heterogeneous smallholder fields or align with farmers' diverse preferences. The objective of this study is to characterize sorghum varieties with differing levels of *Striga* resistance under natural field infestation in southern Niger, focusing on agronomic performance and *Striga* emergence dynamics.

MATERIALS AND METHODS

Experimental site and plant material: Field experiments were conducted during the rainy seasons (July–October) of 2022 and 2023 in Konni, located in the central-southern region of Niger. The site was selected based on a history of severe natural *Striga hermonthica* infestation, thus no Striga seeds were added to the trials to match the farmer's growing conditions. Six sorghum varieties were evaluated: four *Striga*-susceptible varieties (*El_Tsédaoua*, *Mota Maradi*, *MR732*, and *Sepon82*) and two *Striga*-resistant checks (*N13* and *SRN39*).

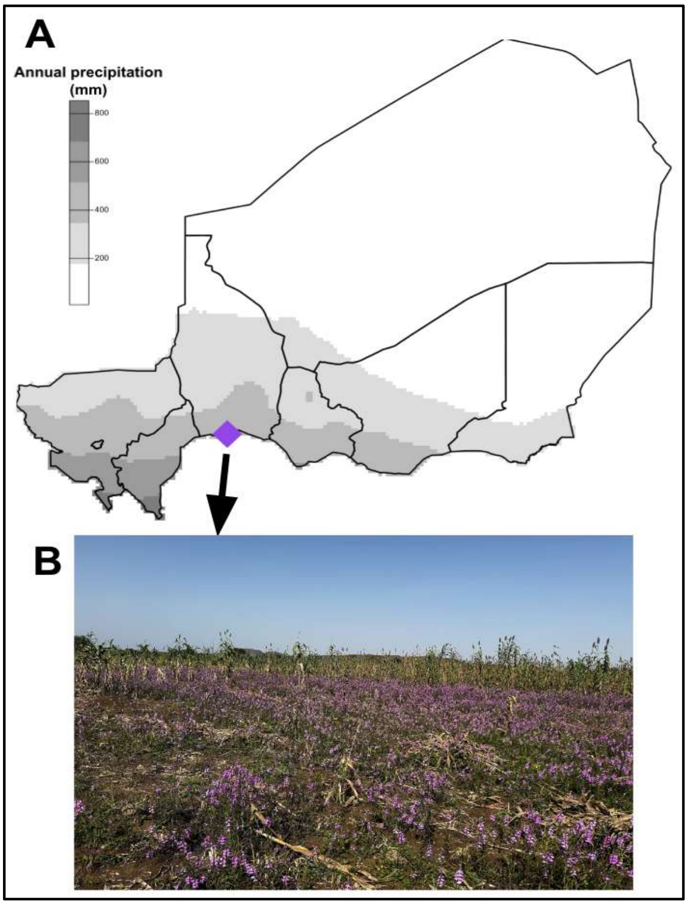

Figure 1. Field experiment site (A) Niger Map with field location; (B) Striga infested farmer's field

Experimental design and crop management: To account for field variability, the experiment followed a randomized complete block design (RCBD) with three replications. Each plot consisted of three rows, 3 m long, with 0.80 m spacing between rows and 0.50 m between hills. Seeds were sown directly, and plants were thinned to 3–4 plants per hill at 14 days after sorghum emergence. Hand weeding was performed to remove non-*Striga* weeds for assessment.

Data collection: Agronomic traits recorded included days to flowering (50% flowering) and plant height (measured at maturity). *Striga*-related traits included days to first *Striga* emergence and the number of emerged *Striga* plants counted at 45, 60, and 90 days after sowing (DAS). Number of Striga plants per hill were counted to estimate the average number of Striga plants per row.

Statistical analysis: Data were subjected to analysis of variance (ANOVA) using a mixed-effects model, with genotype and year treated as fixed effects and replication nested within year as a random effect. The effects of genotype, year, and genotype × year interaction were tested for all traits. Mean comparisons among genotypes were performed using Fisher's least significant difference (LSD) test at *p-value ≤ 0.05*. All statistical analyses were conducted using R statistical software (R Core Team, 2013).

RESULTS AND DISCUSSION

Agronomic performance under natural *Striga* infestation: Analysis of variance revealed significant genotypic effects on days to flowering and plant height across the two cropping seasons (*p-value* ≤ 0.05), indicating inherent differences among the evaluated sorghum varieties in their growth and development under *Striga* pressure. Year effects were also significant, reflecting seasonal variability in environmental conditions, while genotype × year interaction was significant for plant height only. This suggests that while flowering time was relatively stable across environments, vegetative growth responded more strongly to year-to-year variation.

Resistant varieties (*N13* and *SRN39*) exhibited comparatively stable flowering times across both seasons, whereas susceptible varieties showed greater variability. Plant height was generally reduced in susceptible varieties, particularly in 2023, coinciding with higher *Striga* infestation levels. Delayed sorghum growth under *Striga* infestation has been widely reported and is attributed to early underground parasitism, which disrupts host water and nutrient uptake before visible striga emergence (Schulz et al., 2003; Kawa et al., 2021). The relatively stable agronomic performance of resistant varieties suggests a reduced impact of parasitism on sorghum (Badu-Apraku & Fakorede, 2017).

Timing of *Striga* emergence as an indicator of host response: Days to first *Striga* emergence differed significantly among genotypes (*p-value* ≤ 0.01), with resistant varieties consistently delaying parasite emergence compared with susceptible varieties in both years. Early *Striga* emergence was observed in susceptible varieties (El_Tsédaoua and Mota Maradi), indicating rapid parasite germination and successful host attachment shortly after sorghum establishment. Those genotypes are mainly grown in the area for their early maturing and end-users preferences.

A slightly delayed *Striga* emergence in resistant genotypes is commonly associated with reduced stimulation of parasite germination and/or impaired establishment after attachment (Amusan et al., 2011; Gobena et al., 2017; Mallu et al., 2021). Although the underlying mechanisms were not investigated in this study, the observed phenotypic patterns are consistent with resistance based on reduced host–parasite compatibility. Such variability highlights the importance of evaluating resistance across multiple years. While spatial variability in natural conditions

Dynamics of *Striga* infestation: *Striga* density increased significantly from 45 to 90 days after sowing (DAS) for all genotypes (*p-value* ≤ 0.001), reflecting the cumulative nature of parasite emergence over time. However, the magnitude of infestation differed markedly among varieties. Susceptible varieties exhibited high *Striga* densities as early as 45 DAS, with continued increases at 60 and 90 DAS. In contrast, resistant varieties maintained consistently low *Striga* counts throughout the growing season. Genotype × year interactions were significant for *Striga* counts at 60 and 90 DAS (*p-value* ≤ 0.05), indicating that resistance expression varied with environmental conditions. Nevertheless, resistant varieties consistently outperformed susceptible ones across seasons, suggesting relatively stable resistance under field conditions.

Late-season *Striga* emergence is particularly important from a management perspective, as even low Striga plants at later stages can contribute substantially to soil seed banks and future infestations (Rodenburg et al., 2017; Kanampiu et al., 2018). The ability of resistant varieties to suppress *Striga* emergence throughout the season therefore represents a meaningful advantage for sustainable crop production in *Striga*-prone areas.

Environmental influence on resistance expression: The significant year and genotype × year effects observed for several traits confirm the strong influence of environmental factors on *Striga*–host interactions. Rainfall distribution, soil moisture, and temperature are known to affect *Striga* seed conditioning, germination, and host vigor (Bellis et al., 2020, 2021). These findings align with previous studies emphasizing that resistance identified in a single season may not be stable across environments (Rodenburg et al., 2016; Hess et al., 2019).

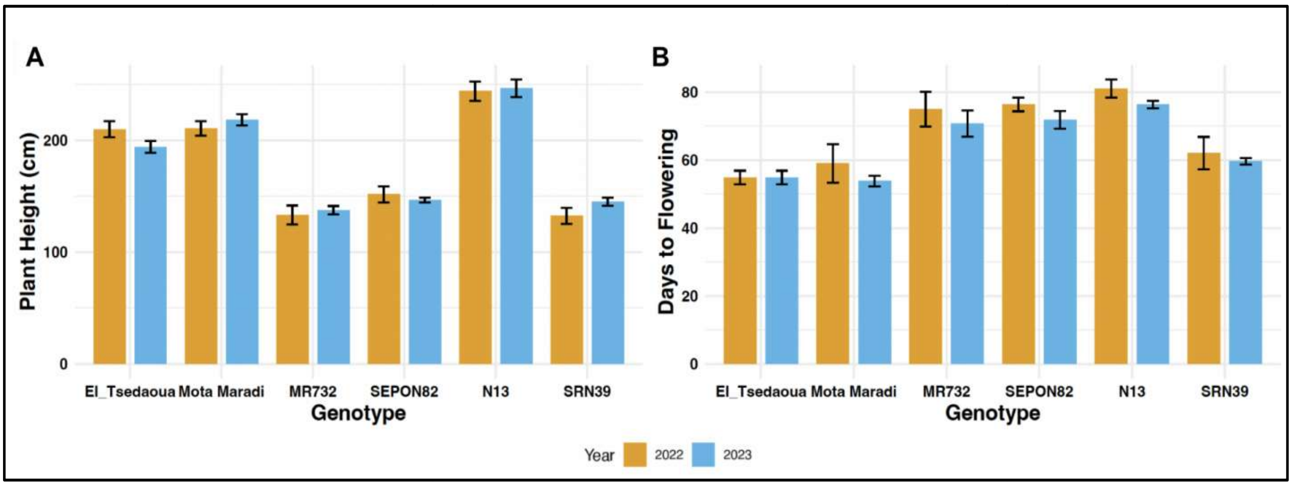

Figure 2. Phenotypic variation of the varieties across two growing seasons. (A) Plant height; (B) Days to flowering

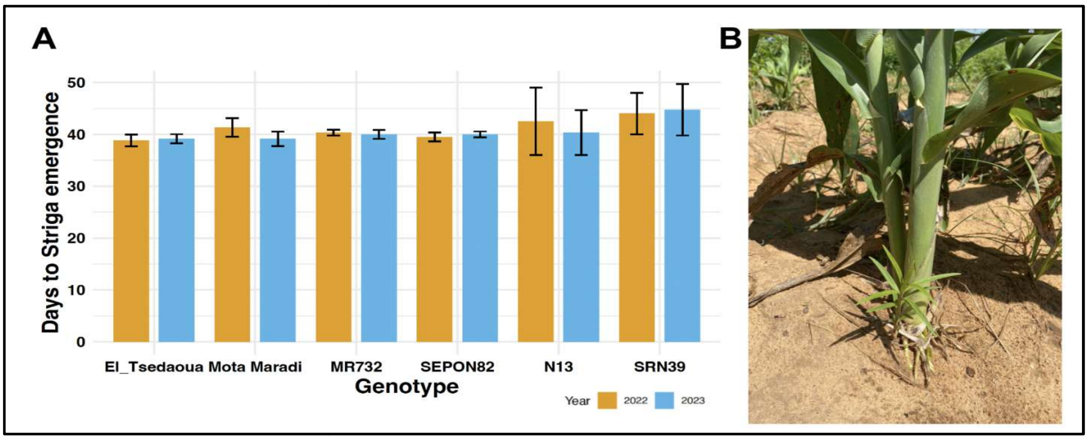

Figure 3.Variation for Days to Striga emergence (A). (B) Striga plant after emergence.

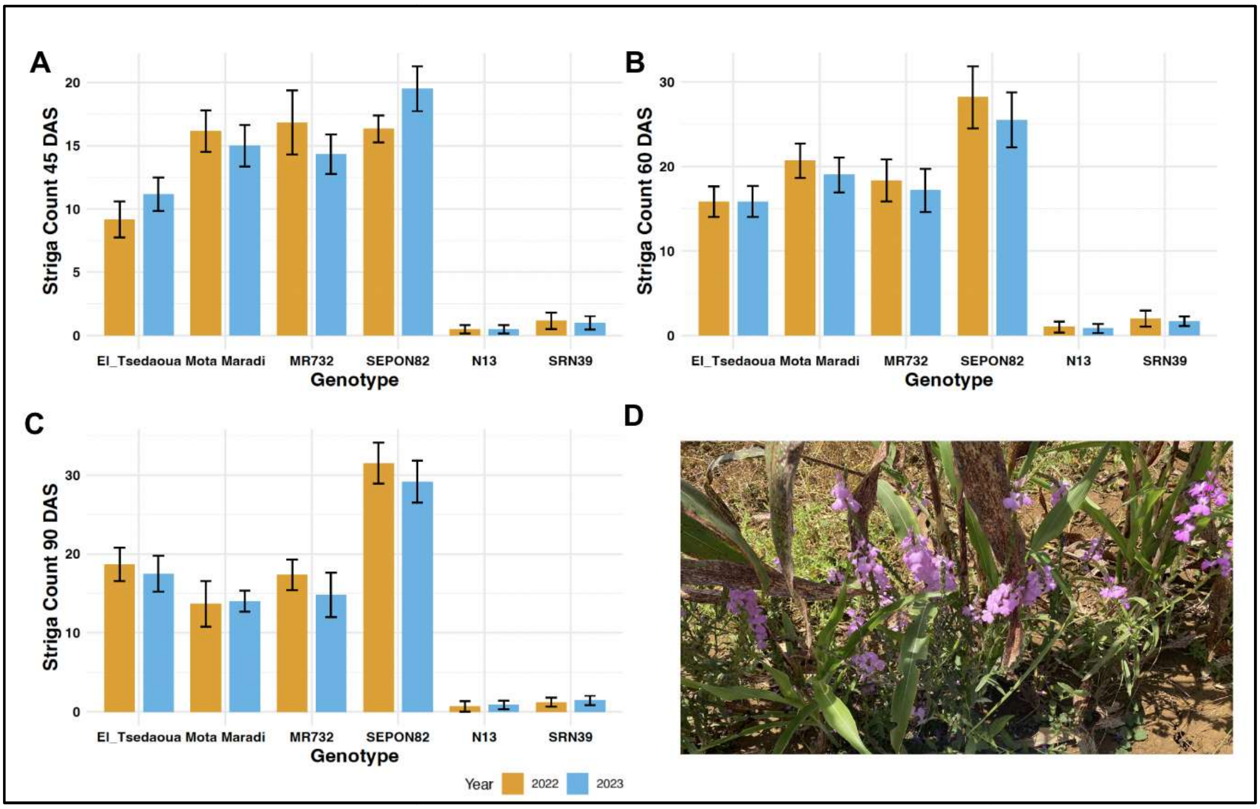

Figure 4. Temporal variation in Striga infestation among sorghum genotypes. (A) Average Striga at 45 Days After Sowing; (B) Average Striga at 60 Days After Sowing; Average Striga at 90 Days After Sowing. (D) Striga plants at flowering infesting susceptible variety

Consequently, multi-year evaluation under natural infestation, as conducted in this study, remains essential for reliable identification of resistant genotypes.

Implications for breeding and deployment: The consistent performance of *N13* and *SRN39* across seasons confirms their value as resistant reference varieties and potential donor parents for breeding programs. While recent advances have identified genetic and molecular mechanisms associated with reduced *Striga* germination and attachment (Gobena et al., 2017; Mbuvi et al., 2017; Runo & Kuria, 2018), field-based phenotypic screening remains indispensable for capturing the combined effects of genotype and environment (Yohannes et al., 2015; Mohemed et al., 2016). Under smallholder farming conditions, varieties must not only exhibit resistance but also maintain acceptable agronomic performance. The combined assessment of flowering time, plant height, *Striga* emergence timing, and density used in this study provides a practical framework for evaluating sorghum varieties under smallholder farming conditions. While yield components were not assessed in this study, a large scale screening may be useful for future evaluation in the growing region to account for spatial and temporal variability, striga ecotypes, and cropping systems.

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