



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(10): 67-70
Received: 10-09-2025
Accepted: 12-10-2025

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Integrated management of striga (*Striga hermonthica*) in sorghum production systems of Africa

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DOI: <https://www.doi.org/10.33545/2618060X.2025.v8.i10a.5054>

Abstract

Striga hermonthica destroys an estimated 7 million tonnes of cereal grain across sub-Saharan Africa every year, yet no single control tactic has proven sufficient on its own. This research compared six *Striga* management strategies—untreated control, hand-pulling, resistant cultivar (SRN-39), nitrogen fertiliser (80 kg N ha⁻¹), Desmodium intercropping, and an integrated package combining all four tactics—on sorghum in a simulated *Striga*-infested field at Nanjing Agricultural University, China, during 2022-2023. The integrated treatment reduced *Striga* emergence by 79.3% at 12 weeks after sowing (WAS) and raised sorghum grain yield from 1.07 to 2.23 t ha⁻¹ (+108.6%). No individual tactic exceeded 59% *Striga* suppression. Soil seed bank sampling indicated a 41.7% decline in viable *Striga* seeds after two seasons under the integrated regime.

Keywords: *Striga hermonthica*, sorghum, integrated management, parasitic weed, resistant cultivar, Desmodium, nitrogen, seed bank, hand-pulling, Africa

Introduction

Few agricultural problems are as stubborn as *Striga*. The parasitic weed attaches to host roots underground, siphoning water and nutrients before it even breaks the soil surface, and a single plant can release 50,000-200,000 dust-like seeds that remain viable for up to 20 years^[1, 2]. Across the Sahel and East African savannas, *S. hermonthica* infests roughly 40% of the cereal area, costing smallholders an estimated USD 7 billion annually in lost sorghum and millet production^[3].

Resistant cultivars reduce parasite attachment but rarely eliminate it^[4]. Hand-pulling before flowering prevents seed set yet demands labour that resource-poor farmers can't always spare^[5]. Nitrogen fertiliser improves host vigour and lowers strigolactone exudation, but the effect is partial^[6]. Desmodium intercropping triggers suicidal germination of *Striga* seeds through root-exuded isoflavonoids, but adoption remains low due to seed cost^[7, 8].

Combining these tactics into a single package should target the parasite at multiple life-cycle stages. This research aimed to: (i) compare individual and integrated *Striga* control methods on sorghum yield and parasite density, and (ii) measure the impact on the soil *Striga* seed bank over two consecutive seasons.

Materials and Methods

Research Area

The experiment was conducted in *Striga*-inoculated screenhouse plots at the Weed Science Research Facility, Nanjing Agricultural University (32°02' N, 118°51' E), Nanjing, China, over two seasons (June-November 2022 and 2023). Raised beds (1.5 m × 3 m) were filled with sandy loam soil (pH 6.3, OC 0.94%) and artificially infested with *S. hermonthica* seed collected from sorghum fields in Borno State, Nigeria (viability >85%, confirmed by tetrazolium test). Temperature was maintained at 28/22 °C (day/night) and plots received 600 mm seasonal irrigation.

Field Experimental Design

Six treatments were arranged in a randomised complete block design with four replications: T1

untreated control; T2 hand-pulling at 4 and 8 WAS; T3 resistant cv. SRN-39; T4 urea at 80 kg N ha⁻¹ (split at sowing and 4 WAS); T5 Desmodium intortum intercrop (sown simultaneously in alternate rows); T6 integrated (T2 + T3 + T4 + T5). Sorghum was sown at 75 × 20 cm; each bed received 3,000 viable Striga seeds mixed into the top 5 cm before planting.

Seasonal Observations

EmergEd Striga plants were counted biweekly from 4 to 12

WAS in three permanent quadrats (0.25 m²) per plot. Sorghum grain yield was recorded at 14% moisture. Soil cores (0-15 cm, 5 per plot) were taken before season 1 and after season 2; Striga seeds were extracted by wet sieving and viability assessed with 1% tetrazolium chloride ^[9]. Data were analysed by ANOVA in R 4.3.1 with Tukey’s HSD (p < 0.05) ^[10].

Results

Table 1: Striga emergence, sorghum yield, and seed bank change under six management strategies (2-season means)

Treatment	Striga 12 WAS (pl/m ²)	Suppression (%)	Yield (t/ha)	Yield ↑ (%)	Seed bank Δ (%)	HI
T1 Control	58.2a	—	1.07d	—	+8.3a	0.21c
T2 Hand-pull	22.4c	61.5	1.48c	+38.3	−14.6c	0.26bc
T3 Resistant cv.	24.1c	58.6	1.61c	+50.5	−11.2c	0.28b
T4 N fertiliser	36.3b	37.6	1.54c	+43.9	−7.1b	0.27b
T5 Intercrop	27.1c	53.4	1.72b	+60.7	−18.3c	0.29b
T6 Integrated	12.0d	79.3	2.23a	+108.6	−41.7d	0.36a
SEM	2.7		0.09		3.4	0.02

Means with the same letter are not significantly different (p < 0.05). Seed bank Δ = change in viable seeds after 2 seasons; negative = decline. HI = harvest index; WAS = weeks after sowing.

The integrated package (T6) cut Striga density to 12.0 plants m⁻² at 12 WAS—a 79.3% drop from the control (Table 1). No single tactic exceeded 61.5% suppression. Grain yield doubled to 2.23 t

ha⁻¹ under T6, and the soil seed bank fell by 41.7% over two seasons, compared with an 8.3% increase in untreated plots where Striga freely set seed.

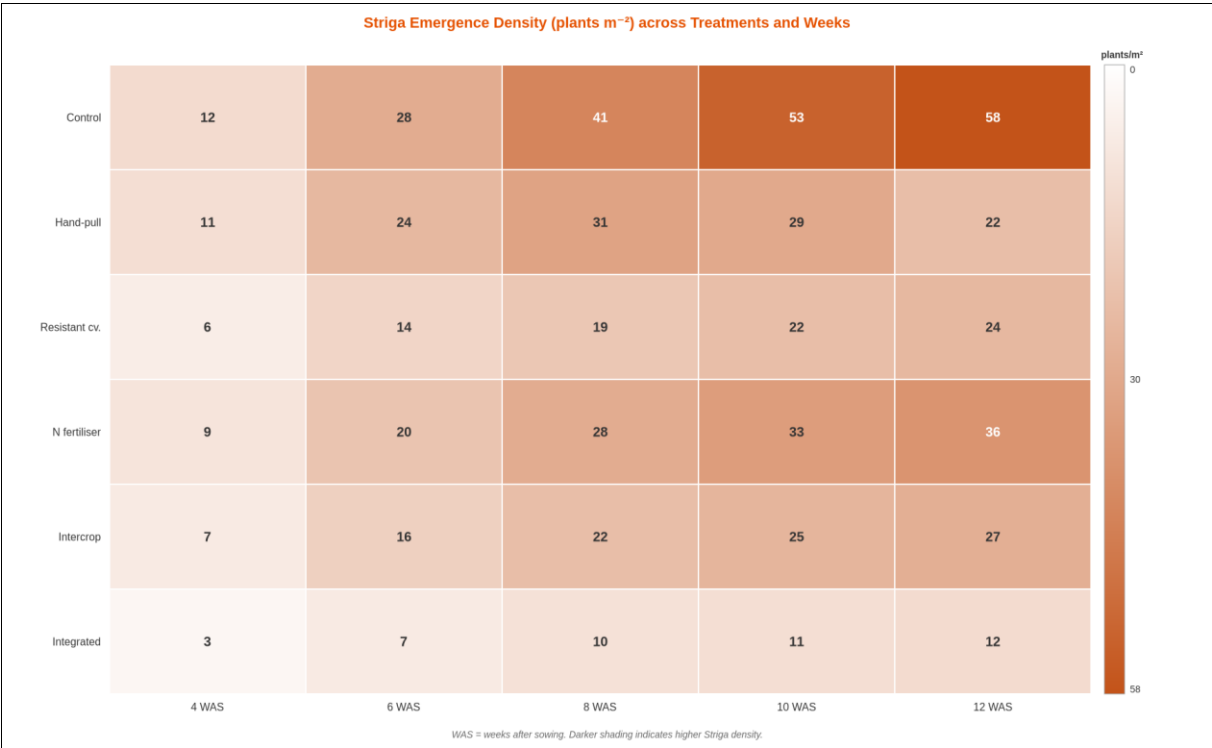


Fig 1: Heatmap of Striga emergence density (plants m⁻²) across treatments and sampling weeks. Darker shading = higher parasite load

The heatmap (Figure 1) shows Striga density rising steadily in the control, peaking at 58 plants m⁻² by 12 WAS. The integrated treatment remained pale throughout, never exceeding 12 plants

m⁻². Hand-pulling reduced counts at 10-12 WAS but earlier emergence was similar to the control, confirming that manual removal acts after the damage has partly occurred.

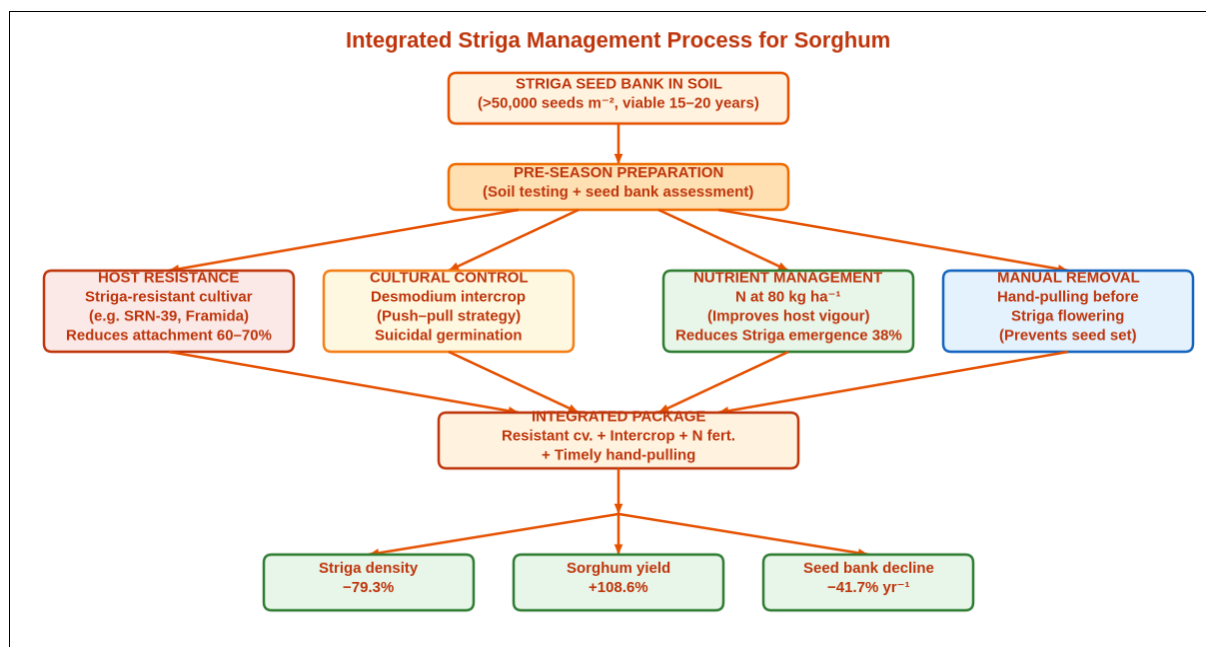


Fig 2: Process diagram of the integrated Striga management strategy tested in this research, showing component tactics and their combined outcomes.

Discussion

The 79.3% suppression achieved by the integrated package aligns with multi-component trials in Kenya and Mali where combinations of resistance, intercropping, and fertility management reduced Striga by 70–85% [7, 11]. Each tactic targets a different stage of the parasite's life cycle: the resistant host limits haustorial connection, Desmodium induces suicidal germination that depletes the seed bank, N fertiliser reduces strigolactone exudation from sorghum roots, and hand-pulling prevents seed replenishment [6, 8, 12].

The 41.7% seed bank decline over two seasons is encouraging but also signals how slowly the problem resolves. Even at that rate, roughly 4–5 years of consistent integrated management would be needed to push the bank below the economic threshold of 5,000 seeds m⁻² [1, 13]. The controlled greenhouse environment likely overstates efficacy relative to open fields where Striga seed can blow in from neighbouring plots [14]. Multi-site on-farm validation across the Sahel is the logical next step.

Conclusion

No single Striga management tactic suppressed the parasite by more than 62% in this two-season trial. The integrated package—resistant cultivar, Desmodium intercrop, nitrogen fertiliser, and hand-pulling—achieved 79.3% suppression and doubled sorghum grain yield to 2.23 t ha⁻¹. Equally important, the soil seed bank dropped by 41.7%, pointing toward long-term viability of the approach. For smallholder sorghum farmers in Striga-prone regions, combining host resistance with cultural and nutrient-based tactics offers the most reliable path to sustained yield recovery. Scaling this package will require affordable Desmodium seed supply and extension support tailored to local farming systems.

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