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Integrated Effects of Seed Treatment, Sowing Date, and Trap Cropping on the Management of *Striga hermonthica* in Sorghum Production Systems

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Abstract

Striga hermonthica is a major constraint to sorghum production in sub-Saharan Africa, causing severe yield losses under low-input farming systems. This study evaluated the integrated effects of seed treatment using *Parkia* pulp powder, sowing date, and trap cropping with soybean on *Striga* infestation and sorghum performance. Field experiments were conducted during the 2023 and 2024 cropping seasons at the Federal University of Technology, Minna, Nigeria, using a randomized complete block design in a 2 × 3 × 2 factorial arrangement. Data collected included *Striga* emergence, shoot count, severity, and sorghum growth and yield parameters. Results showed that delayed sowing (July) significantly reduced *Striga* emergence, density, and severity, while soybean intercropping further suppressed infestation. Grain yield was significantly higher under July planting, particularly in 2024. The study demonstrates that integrating sowing date adjustment and trap cropping provides a sustainable and cost-effective approach for managing *Striga hermonthica* in sorghum production systems.

Keywords: *Striga hermonthica*, Sorghum, Integrated Weed Management.

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Introduction

Sorghum (*Sorghum bicolor* L.) is a major staple cereal widely cultivated in sub-Saharan Africa, particularly in the savanna agro-ecological zones where it contributes significantly to food security and rural livelihoods. Despite its adaptability to drought-prone environments, sorghum productivity remains low due to several biotic constraints, among which *Striga hermonthica* is the most devastating parasitic weed (Atera *et al.,* 2021; Jamil *et al.,* 2022). *Striga hermonthica* is an obligate root parasite that attaches to host plants and extracts water, nutrients, and assimilates, thereby reducing plant vigor and yield. Yield losses ranging from 30 to 100% have been reported depending on infestation severity, soil fertility status, and environmental conditions (Khan *et al.,* 2023). The problem is further aggravated by the production of large quantities of long-lived seeds that can persist in the soil for over a decade, making its control extremely difficult (Samejima *et al.,* 2022).

The germination of *Striga* seeds is stimulated by strigolactones exuded from host plant roots, creating a highly specialized host–parasite interaction. This biological dependency complicates management, as conventional weed control methods are often ineffective once attachment has occurred (Jamil *et al.,* 2022). Consequently, integrated management strategies that target different stages of the *Striga* life cycle are widely recommended. Among the most promising approaches is the use of trap crops, particularly legumes such as soybean, which stimulate *Striga* seed germination without supporting parasite development, resulting in suicidal germination and depletion of the soil seed bank (Samejima *et al.,* 2022; Khan *et al.,* 2023). In addition, intercropping systems involving legumes have been shown to improve soil fertility and suppress *Striga* infestation through both biological and ecological mechanisms (Atera *et al.,* 2021). Sowing date manipulation is another important agronomic practice that influences *Striga* dynamics. Adjusting planting time can disrupt the synchronization between host root growth and *Striga* germination, thereby reducing infestation levels (Emechebe *et al.,* 2024). Delayed planting has been reported to reduce *Striga* emergence due to unfavorable environmental conditions for parasite development. Furthermore, the use of plant-based seed treatments is gaining attention as an eco-friendly approach to weed management. Organic materials such as *Parkia biglobosa* pulp contain bioactive compounds with potential allelopathic effects that may inhibit *Striga* germination or attachment (Ibrahim *et al.,* 2022).

However, their effectiveness under field conditions remains insufficiently explored. Despite the availability of these individual control strategies, their combined effects under field conditions in the Nigerian savanna are not well documented. Therefore, this study was conducted to evaluate the integrated effects of seed treatment, sowing date, and trap cropping on *Striga hermonthica* infestation and sorghum productivity.

Materials and Methods

The experiment was conducted during the 2023 and 2024 cropping seasons at the Striga-infested research farm of the Federal University of Technology, Minna, located within the Southern Guinea Savannah agro-ecological zone of Nigeria. The site is characterized by sandy clay loam soil, mean annual rainfall of approximately 1300 mm, and a history of severe Striga infestation.

Experimental Design and Treatments

The experiment was a 2 × 3 × 2 factorial arranged in a randomized complete block design with three replications. Treatments consisted of: Sorghum varieties: resistant ICSV 1002 and susceptible local variety. *Parkia* pulp concentrations: 0, 66 and 100 g L^{-1} and Cropping system: sole sorghum and sorghum intercropped with soybean (TGX 1448-2E)

Land Preparation

Plots were manually ridged at 75 cm spacing. Soybean was planted three days before sorghum, while sorghum was sown at 30 cm intra-row spacing. Standard agronomic practices including thinning and manual weeding were carried out.

Parkia Pulp Preparation and Seed Treatment

Parkia fruits were processed to obtain pulp powder, which was used to treat sorghum seeds at concentrations mention above prior to sowing.

Data Collection

Data collected included: Number of days to first *Striga* emergence, *Striga* shoots count per sorghum plant at 10, 14 and 18 WAS, number of *Striga* shoot flowering at 14 and 18 WAS, *Striga* severity (% age crop infestation or degree of damage). Sorghum plant height at 10 and 14 WAS from the three inner- most ridges..Plant height measured from the base to the tip of the upper most leaves at 10 and 14 WAS.1000 grain weight and grain yield. Data were subjected to ANOVA using Genstat software, and treatment means were separated using LSD at 5% probability level.

Results and Discussion

Results from Table 1 showed that days to first *Striga* emergence (DFE) were influenced by both cropping system and sowing date. In 2023, *Striga* emergence was delayed under sole sorghum planted in July (64.83 days) compared to June planting (59.61 days). Similarly, soybean intercropping maintained relatively stable but slightly delayed emergence across both sowing dates. In 2024, delayed planting also resulted in slightly higher DFE values, particularly under sole sorghum. The delayed emergence observed under July planting suggests that sowing date plays a critical role in disrupting the synchronization between host root growth and *Striga* germination. This finding agrees with Emechebe *et al.,* (2024), who reported that adjusting planting time can reduce *Striga* infestation by exposing the parasite to suboptimal environmental conditions.

Striga shoot count per stand (SCS) and per plot (SCP) were consistently lower under July planting across both years. For instance, in 2024 at 10 WAS, sole sorghum planted in July recorded lower shoot counts (2.55) compared to June planting (4.69). A similar trend was observed under soybean intercropping, where the lowest shoot counts (1.57) were recorded in July planting. These reductions indicate that delayed sowing limits successful establishment of *Striga*.

Soybean intercropping further reduced *Striga* shoot density compared to sole sorghum, particularly at early growth stages. This supports the role of soybean as a trap crop, which induces suicidal germination of *Striga* seeds. Similar findings have been reported by Samejima *et al.,* (2022), who demonstrated that legume trap crops significantly reduce *Striga* seed bank through germination stimulation without host attachment.The interaction between sowing date and cropping system showed that the combination of soybean intercropping and July planting produced the lowest *Striga* shoot density, indicating a synergistic effect. This aligns with the findings of Khan *et al.,* (2023), who emphasized that integrated agronomic practices are more effective in suppressing *Striga* than single control measures. shoot flowering (SSF) was not significantly affected by treatments in both years, suggesting that while treatments influenced *Striga* establishment and density, they had limited effect on reproductive development once the parasite was established.

As presented in Table 2, *Striga* severity score (SC) was significantly reduced under July planting in 2023. Sole sorghum planted in June recorded higher severity (5.00) compared to July planting (3.78), while sorghum intercropped with soybean showed even lower severity levels (2.83) under July planting. However, no significant differences were observed in 2024, suggesting that environmental conditions influenced treatment effectiveness. The reduction in severity under delayed planting may be attributed to reduced parasite attachment and establishment. This is consistent with findings by Atera *et al.,* (2021), who reported that environmental factors such as rainfall and soil moisture significantly affect *Striga* infestation intensity.

Sorghum plant height (PH) was generally higher under reduced *Striga* pressure. In 2023, plants grown under July planting recorded greater heights at both 10 and 14 WAS compared to June planting. This indicates that reduced parasitic stress allowed better crop growth. However, variations observed in 2024 suggest that environmental conditions also influenced plant development. The improvement in plant height under lower *Striga* infestation agrees with Jamil et al. (2022), who reported that *Striga* significantly reduces host plant growth by limiting nutrient and water uptake.

Grain yield (GY) was significantly influenced by sowing date and cropping system. In 2024, higher yields were recorded under July planting across both cropping systems. For example, sorghum intercropped with soybean in July produced higher yield (1546.80 kg/ha) compared to June planting (1433.10 kg/ha). Similarly, sole sorghum showed increased yield under July planting.The increase in grain yield under delayed planting can be attributed to reduced *Striga* competition and improved plant growth. This finding is consistent with Khan *et al.,* (2023), who reported that integrated *Striga* management practices significantly enhance crop productivity. Although 1000 grain weight (GW) did not show significant differences across treatments, the overall yield improvement suggests that the primary effect of treatments was on plant establishment and growth rather than grain size.

Conclusion and Recommendation

The combined effects of sowing date and cropping system clearly demonstrate that integrated management strategies are more effective than single approaches. The interaction between soybean intercropping and delayed sowing produced the lowest *Striga* infestation and highest sorghum yield. This supports the concept of integrated weed management, which emphasizes the use of complementary strategies targeting different stages of the weed life cycle. According to Atera *et al.,* (2021) and Samejima *et al.,* (2022), combining cultural practices such as intercropping and planting time adjustment offers a sustainable and cost-effective solution for managing *Striga* in smallholder farming systems.

Overall, the results confirm that delayed sowing and soybean trap cropping can significantly reduce *Striga hermonthica* infestation and improve sorghum productivity, particularly when used in combination. Farmers should adopt resistant sorghum varieties combined with soybean intercropping. Botanical seed treatments such as Parkia pulp should be further promoted.

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Tables

Table 1: Interaction effect of cropping system and sowing date on days to first *Striga* shoot emergence, *Striga* count per ***stand and per plotand Striga shoot flowering.***

		2023									2024								
		DFE	**SCS**			**SCP**			**SSF**		**DFE**	**SCS**			**SCP**			**SSF**	
cropping system	sowing dates		10	14	18	10	14	18	14	18		10	14	18	10	14	18	14	18
Sole sorghum	June	59.61	5.89	8.72	9.72	3.83	7.00	8.11	9.17	9.94	60.17	4.69	7.00	9.00	7.00	9.00	10.78	6.39	8.11
Sole sorghum	July	64.83	3.78	6.72	7.61	9.5	6.37	7.28	8.83	9.5	61.22	2.55	3.94	5.72	4.61	6.89	8.28	3.94	4.83
Soyabean	June	57.72	3.56	5.78	6.39	3.28	13.44	13.89	5.17	5.94	60.5	3.67	4.3	6.28	4.94	6.56	8.44	4.34	5.83
Soyabean	July	57.72	3.50	4.61	5.11	8.85	13.85	15.78	5.33	5.94	59.44	1.57	2.58	4.11	2.19	4.17	5.72	2.39	2.72
		59.97	4.18	6.46	7.21	6.37	10.17	11.27	7.13	7.83	60.33	3.12	4.46	6.28	4.69	6.66	8.31	4.27	5.37
LSD (0.05)		0.47	0.71	NS	NS	NS	NS	1.36	NS	NS	0.67	NS	0.81	NS	0.71	0.92	NS	NS	NS

***DFE:** Day to first Striga emergence,* ***SCS:** Striga shoot count per stand,* ***SCP:** Striga shoot count per plot,* ***SSF:**Striga shoot flowering,* ***NS**: Non significant,* ***LSD:** Probability level at 0.05*

Table 2: Interaction effect of cropping system and sowing date on severity score, plant height (cm), grain weights and grain yield (kg/ha**)**

		2023					**2024**				
		SC	**PH Weeks After Sowing**		**GY**		**SC**	**PHWeeks After Sowing**		**GY**	
Cropping system	**sowing dates**		**10**	**14**	**1000 GW**	**GY**		**10**	**14**	**1000 GW**	**GY**
Sole sorghum	June	5.00	47.00	55.83	30.06	1447.1	4.39	42.33	49.61	33.12	1280.70
Sole sorghum	July	3.78	48.89	57.78	31.16	1639.1	4.17	43.67	48.00	30.48	1457.40
Sorghum + Soyabean	June	3.61	30.00	39.17	20.12	1130.4	3.89	49.33	55.89	33.96	1433.10
Sorghum + Soyabean	July	2.83	36.39	45.39	20.91	1290.6	3.56	45.94	53.17	32.40	1546.80
Mean		3.82	40.57	49.54	25.56	1376.8	4.00	45.32	51.67	32.49	1429.50
LSD (0.05)		0.24	2.36	2.22	NS	NS	NS	1.86	NS	NS	39.22

***DFE:** Day to first Striga emergence,* ***SCS:** Striga shoot count per stand,* ***SCP:** Striga shoot count per plot,* ***SSF:**Striga shoot flowering,* ***NS**: Non significant,* ***LSD:** Probability level at 0.05*