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Integrated Weed Management for Enhanced Growth and Yield Performance of Soybean (*Glycine max* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors JD and LTL conceived, designed the research and carried out the concept. Authors RS and GZ prepared the figure, analysis & wrote the full paper. All the authors equally contributed to the entire writing. All the authors given consent to submit the manuscript. Authors GZ, RS and SSK read and approved the final version of the manuscript.

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ABSTRACT

Soybean (*Glycine max* L.) is a vital oilseed and pulse crop, but its productivity is severely constrained by weed competition, causing yield losses of up to 30–80%. To address this, a field experiment was conducted during the *kharif* seasons of 2019 and 2020 at the Agronomy Farm, School of Agricultural Sciences, Nagaland University, Medziphema, Nagaland, on acidic sandy loam soils under rainfed conditions. The study followed a randomized block design with eight treatments to evaluate the effect of integrated weed management (IWM) on soybean growth and yield. Treatments included pre- and post-emergence herbicides (Pendimethalin, Imazethapyr,

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Sulfentrazone) either alone or combined with intercultivation (IC) or hand weeding, along with unweeded control. Results indicated significant differences among treatments. IC at 20 DAS followed by hand weeding at 40 DAS (T7) recorded the maximum plant height (60.90 cm), number of branches (5.20), and dry matter accumulation (2.36 g plant^{-1}). The same treatment also produced the highest grain yield (2064.67 kg ha^{-1}), stover yield (2458.79 kg ha^{-1}), and biological yield (4523.46 kg ha^{-1}). Herbicide + intercultivation treatments such as Imazethapyr fb IC (T4) and Pendimethalin fb IC (T2) also performed well, whereas the unweeded control consistently recorded the lowest growth and yield, with ~52% reduction in grain yield compared to T7. The findings suggest that integrated weed management, particularly the combination of intercultivation and hand weeding, ensures season-long weed control, enhances crop growth, and maximizes soybean productivity in acidic rainfed soils of Northeast India.

Keywords: Soybean; integrated weed management; growth; yield; intercultivation; sustainability.

1. INTRODUCTION

Soybean (*Glycine max* L. Merrill) is one of the most important oilseed and pulse crops of the world, valued for its high protein (40–42%) and oil content (18–20%) (Jin et al., 2023). In India, soybean occupies a prominent place in the rainfed cropping systems, contributing significantly to edible oil supply and nutritional security (Prashnani et al., 2024). Despite its potential, productivity in soybean is often constrained by weed competition, which is recognized as the single largest factor responsible for yield losses ranging from 30–80%, depending on the type and duration of weed infestation (Sridhar et al., 2025; Gharde et al., 2018).

Soybean is highly sensitive to weed competition during its early growth stages, as slow canopy closure provides a favorable environment for rapid weed emergence and establishment. Weeds not only reduce crop yield by competing for nutrients, moisture, and light but also adversely affect crop growth parameters such as plant height, branching, and biomass accumulation (Caldas et al., 2023; Chauhan et al., 2017; Kaur & Singh, 2021). Therefore, timely and effective weed management is essential to ensure optimum growth and productivity of soybean.

Traditionally, weed control in soybean has relied on either manual weeding or chemical herbicides. While manual weeding is effective, it is labor-intensive, time-consuming, and often impractical due to high labor costs and limited availability. On the other hand, sole dependence on herbicides poses risks of herbicide resistance, environmental pollution, and shifts in weed flora (Parven et al., 2025; Heap, 2014). This necessitates a more sustainable approach, wherein Integrated Weed Management (IWM) the judicious combination of chemical, cultural, and manual methods offers a viable solution (Swanton & Weise, 1991).

Several studies have reported that integrated practices such as pre-emergence herbicide application followed by intercultivation and hand weeding provide season-long weed control, enhance soybean growth, and improve yield performance (Vishwakarma et al., 2023; Rudell et al., 2023). Moreover, IWM reduces production costs, delays herbicide resistance, and enhances soil health, making it a sustainable strategy (Ramesh et al., 2017; Chauhan, 2020). However, the relative effectiveness of different IWM strategies on both growth and yield parameters under local conditions remains inadequately explored.

Hence, the present investigation was undertaken to evaluate the effect of integrated weed management practices on growth attributes and yield performance of soybean. The study aimed to identify the most effective and sustainable combination of weed management practices to enhance soybean productivity while reducing reliance on herbicides.

Soybean in acidic and rainfed soils faces higher weed pressure due to poor crop vigor, delayed canopy closure, and erratic rainfall that favors early-emerging weeds. Under such conditions, weeds compete more aggressively for moisture and nutrients, leading to severe yield penalties. Hence, reliance on a single control method is inadequate, and integrated weed management (IWM) combining cultural practices, timely herbicide application, and mechanical measures becomes essential to maintain productivity. Studies have shown that IWM approaches not only suppress weeds effectively but also enhance resource use efficiency and stabilize soybean yields in rainfed ecosystems (Naithani et al., 2025).

2. MATERIALS AND METHODS

2.1 Experimental Site and Soil Characteristics

The field trial was conducted during the *kharif* seasons of 2019 and 2020 at the Agronomy Farm, School of Agricultural Sciences, Nagaland University, located at 25.71254° N latitude, 95.83214° E longitude, and an altitude of 310 meters above sea level. The experimental soil was sandy loam in texture, with a pH of 4.63 and organic carbon content of 1.07%. The soil contained 328.65 kg ha^{-1} of available nitrogen, 13.44 kg ha^{-1} of available phosphorus, and 165.87 kg ha^{-1} of available potassium.

2.2 Crop and Agronomic Details

The soybean variety JS 97-52 was used, with a seed rate of 65 kg ha^{-1}, and spacing of 45 cm × 10 cm was maintained between rows and plants, respectively. Herbicide treatments were applied using a knapsack sprayer. Recommended doses of fertilizer 25:60:40 (N: P_2O_5:K_2O) kg ha^{-1}.

2.3 Weed Management Treatments

Integrated weed management in soybean combines herbicides, intercultivation, and hand weeding for effective control. It reduces weed pressure, minimizes herbicide resistance, and enhances crop growth. This approach ensures sustainable productivity and better resource use efficiency.

2.4 Observations Recorded

- Growth parameters: plant height (cm), number of primary branches per plant, and dry matter accumulation (g $plant^{-1}$) were recorded at 30 DAS, 60 DAS, and harvest. For the assessment of growth parameters, five healthy plants were randomly selected from each plot. Plant samples were collected at different intervals, shade-dried, and then oven-dried to determine dry matter accumulation. For weed dynamics, weed samples were collected using a 0.5 m^2 quadrat, and counts were extrapolated to per square meter basis.
- Yield attributes: grain yield (kg ha^{-1}), stover yield (kg ha^{-1}), and biological yield (kg ha^{-1}) were measured at harvest.

2.5 Statistical Analysis

The data collected from various parameters were subjected to analysis of variance (ANOVA) appropriate for Randomized Block Design. Treatment means were compared at the 5% level of significance (P=0.05) using Critical Difference (CD) values outlined by Gomez and Gomez (1984). Standard error of mean (SEm±) was also computed to assess the precision of experimental results.

Table 1. Eight weed management practices were tested

T1: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} (Pre-emergence)
T2: Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} fb IC at 30 DAS
T3: Imazethapyr 10 SL @ 100 g a.i. ha^{-1} (Post-emergence at 20 DAS)
T4: Imazethapyr 10 SL @ 100 g a.i. ha^{-1} (10 DAS, early post-emergence) fb IC at 30 DAS
T5: Sulfentrazone 48 SC @ 360 g a.i. ha^{-1} (Post-emergence at 20 DAS)
T6: Sulfentrazone 48 SC @ 360 g a.i. ha^{-1} (early post-emergence) fb IC at 30 DAS
T7: Inter-cultivation at 20 DAS fb hand weeding at 40 DAS
T8: Unweeded control

(*fb – followed by; IC – inter-cultivation; DAS – days after sowing*)

Table 2. Effect of integrated weed management on growth parameters at different stages of soybean crop (pooled mean data of 2019 and 2020)

Treatments	Plant height (cm)			Number of primary branches $plant^{-1}$			Dry weight of plant (g $plant^{-1}$)	
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS
T_1	22.44	52.60	50.50	1.50	3.58	4.52	0.48	1.95
T_2	25.77	54.07	52.73	1.89	3.92	4.90	0.62	2.09
T_3	24.07	53.80	52.72	1.61	3.84	4.84	0.54	2.05
T_4	25.43	58.25	56.56	1.76	3.92	4.93	0.62	2.33
T_5	22.33	51.93	48.82	1.31	3.47	4.48	0.46	1.93
T_6	23.75	53.34	50.97	1.52	3.62	4.74	0.51	2.04
T_7	25.24	60.90	58.20	1.66	4.10	5.20	0.59	2.36
T_8	20.56	46.44	43.04	1.21	3.11	3.45	0.44	1.78
SEm±	0.45	1.49	1.23	0.09	0.13	0.15	0.02	0.06
CD (P=0.05)	1.29	4.32	3.55	0.27	0.37	0.42	0.05	0.17

Table 3. Effect of integrated weed management on Yield parameters of soybean crop (pooled mean data of 2019 and 2020)

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (%)
T_1	1572.61	2132.34	3704.95
T_2	1967.36	2295.46	4262.82
T_3	1754.11	2258.79	4012.90
T_4	2005.26	2347.13	4352.38
T_5	1534.83	1937.13	3471.96
T_6	1729.15	2212.13	3941.27
T_7	2064.67	2458.79	4523.46
T_8	997.67	1312.13	2309.79
SEm±	*46.11*	*56.06*	*68.49*
CD (P=0.05)	*133.58*	*162.40*	*198.41*

3. RESULTS AND DISCUSSION

3.1 Plant height

Soybean plant height was significantly influenced by weed management practices at all stages of growth. At 30 DAS, taller plants were observed in T2 (Pendimethalin fb IC at 30 DAS; 25.77 cm), T4 (Imazethapyr fb IC at 30 DAS; 25.43 cm), and T7 (IC at 20 DAS fb HW at 40 DAS; 25.24 cm), which were statistically superior to the unweeded control (20.56 cm). At 60 DAS, maximum plant height (60.90 cm) was recorded under T7, followed by T4 (58.25 cm) and T2 (54.07 cm), while the lowest (46.44 cm) was recorded in T8 (control). A similar trend was observed at harvest, where T7 again produced the tallest plants (58.20 cm) (Table 2).

This trend indicates that effective weed suppression during the early crop stages reduced crop–weed competition for light, nutrients, and water, thereby enhancing vegetative growth. Similar results were reported by Gajendra et al. (2023), who found that pre-emergence herbicide combined with intercultural operations significantly improved soybean height due to better weed control and resource availability. Recent studies by Saba et al. (2023) and Sharma et al. (2025) also confirmed that integrating herbicides with cultural practices significantly improves soybean vegetative growth by minimizing early-stage weed pressure.

3.2 Number of Primary Branches $Plant^{-1}$

The number of branches per plant was significantly higher under integrated treatments. At harvest, the maximum branching was recorded in T7 (5.20 branches $plant^{-1}$), followed by T4 (4.93) and T2 (4.90), whereas the minimum (3.45) was observed in the unweeded control. The increase in branching under IWM practices reflects improved canopy architecture and efficient resource utilization (Table 2).

These results are in agreement with Rudell et al. (2023), who highlighted that manual weeding in combination with herbicide application promoted branching and improved canopy development in soybean. Additionally, Sridhar et al. (2025), observed that IWM practices significantly influenced plant architecture by improving branching, thereby increasing the potential photosynthetic surface area.

3.3 Dry Weight of Plant

Biomass accumulation (dry matter) was also significantly affected. At 60 DAS, the maximum dry matter was recorded in T7 (2.36 g $plant^{-1}$), followed by T4 (2.33 g $plant^{-1}$) and T2 (2.09 g $plant^{-1}$). The lowest (1.78 g $plant^{-1}$) was found in the control (T8). At harvest, T7 maintained superiority, reflecting the positive impact of prolonged weed suppression on biomass production (Table 2).

The increase in dry matter under integrated treatments suggests that combining chemical and manual methods ensures effective control of both early and late-emerging weeds. These findings corroborate those of Caldas et al. (2023), who observed that integrated herbicide–manual weeding practices significantly enhanced biomass accumulation in soybean compared to herbicide or manual weeding alone. Similar results were reported by Gerhards et al. (2024) and Sridhar et al. (2025), emphasizing that IWM reduces weed pressure and enhances biomass partitioning in soybean.

3.4 Grain Yield

The grain yield of soybean was significantly influenced by weed management practices. The highest grain yield was recorded in T7 (IC at 20

DAS fb hand weeding at 40 DAS; 2064.67 kg ha⁻¹), followed by T4 (Imazethapyr early post-emergence fb IC at 30 DAS; 2005.26 kg ha⁻¹) and T2 (Pendimethalin fb IC at 30 DAS; 1967.36 kg ha⁻¹). These were statistically superior to other treatments. The lowest grain yield was observed in the unweeded control (T8; 997.67 kg ha⁻¹), which accounted for nearly a 52% reduction compared to T7 (Table 3 & Fig. 1).

The improved grain yield under integrated approaches may be attributed to effective and prolonged weed control, leading to reduced crop weed competition and higher resource-use efficiency. Similar findings were reported by Sridhar et al. (2025), who documented yield losses exceeding 50% under uncontrolled weed growth. More recent studies by Chaudhary et al. (2021) and Gupta et al. (2023) further support that herbicide + intercultural or manual interventions consistently produce higher soybean grain yields compared to herbicide alone.

3.5 Stover Yield

Stover yield exhibited trends similar to grain yield. The maximum stover yield was obtained in T7 (2458.79 kg ha⁻¹), which was statistically superior to all other treatments. Treatments T4 (2347.13 kg ha⁻¹) and T2 (2295.46 kg ha⁻¹) also produced significantly higher stover yields than other herbicidal treatments. The unweeded control recorded the lowest stover yield (1312.13 kg ha⁻¹), demonstrating the adverse effect of unchecked weed growth on vegetative biomass production (Table 3 & Fig. 1).

The improvement in stover yield under integrated treatments could be attributed to reduced weed density, prolonged nutrient availability, and enhanced vegetative growth. Caldas et al. (2023) similarly noted that integrating manual weeding with herbicides significantly improves stover yield in soybean. Furthermore, Dhanush et al. (2025) observed that stover yield increased by 20–35% when intercultivation and manual weeding were integrated with pre-emergence herbicides.

3.6 Biological Yield

Biological yield, being the sum of grain and stover yield, was also significantly higher in integrated treatments. The maximum biological yield was recorded under T7 (4523.46 kg ha⁻¹), followed by T4 (4352.38 kg ha⁻¹) and T2 (4262.82 kg ha⁻¹). In contrast, the lowest biological yield was obtained in the control treatment (2309.79 kg ha⁻¹) (Table 3 & Fig. 1).

The superiority of T7 over all other treatments confirms that integrated weed management is essential for season-long weed control and ensures both higher grain and stover productivity. These findings are in line with Vishwakarma et al. (2023), who emphasized that IWM ensures greater system productivity and resilience in soybean systems compared to sole herbicide use. Beam et al. (2021) also reported that integrated weed control leads to higher system sustainability and biological yield.

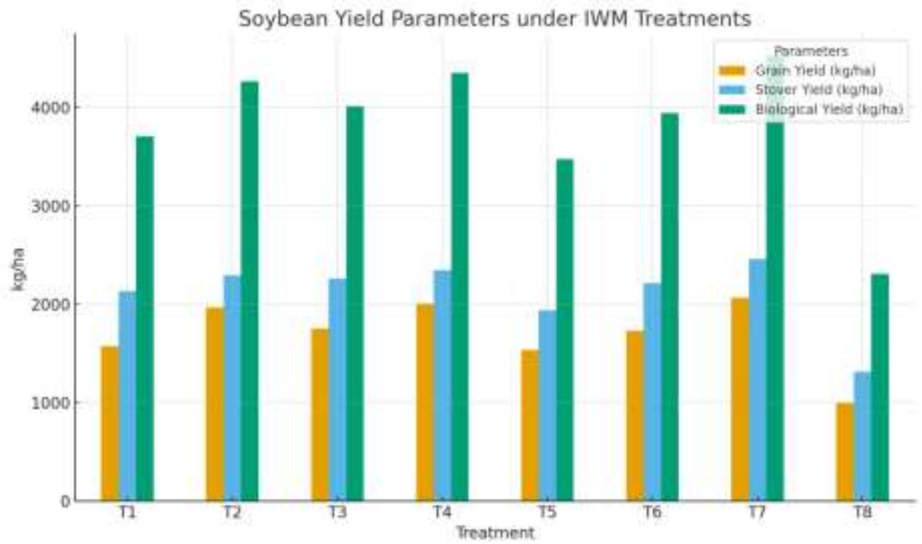

Fig. 1. Effect of integrated weed management on Yield parameters of soybean crop

The superiority of integrated treatments (herbicide + intercultivation or IC + HW) indicates that The superiority of integrated treatments (herbicide + intercultivation or IC + HW) indicates that no single method was sufficient for season-long weed control, and integration provided sustained suppression. Similar observations were made by Vishwakarma et al. (2023). Recent evidence from Beam et al. (2021) and Pokhrel et al. (2025) also supports that IWM ensures higher system productivity and resilience of soybean-based cropping systems compared to sole herbicidal practices. Beyond biological effectiveness, the economic feasibility of IWM merits attention. While intercultivation and hand weeding involve higher labor inputs, their combination with herbicides reduces the frequency and intensity of manual operations, striking a balance between labor availability and cost efficiency. Treatments relying solely on hand weeding may become uneconomical under rising wage rates, whereas sole herbicide use can lower costs but often leads to partial control and higher risk of resistance buildup. Integrated options, therefore, optimize resource use by reducing weed density at critical stages with herbicides, followed by cost-effective mechanical or manual interventions. This trade-off between labor and herbicide costs underscores the practicality of IWM, making it not only agronomically superior but also economically sustainable in smallholder rainfed soybean systems.

4. CONCLUSION

Overall, the pooled data clearly indicate that integrated approaches, especially the combination of intercultivation with timely hand weeding, ensure season-long weed suppression, enhance soybean growth, and maximize productivity. Such strategies are crucial for achieving higher resource-use efficiency, reducing yield losses due to weeds, and sustaining soybean cultivation in the long run.

The study clearly demonstrates that soybean growth and productivity are highly dependent on effective weed control. Among the evaluated practices, IC at 20 DAS followed by hand weeding at 40 DAS (T7) was the most effective in improving plant height, branching, biomass accumulation, and yield attributes. Treatments combining herbicide application with intercultivation (T4 and T2) also showed superiority over sole herbicide use. In contrast, the unweeded control consistently produced the lowest values across all parameters, confirming that unchecked weed competition can reduce soybean yield by more than 50%.

The pooled findings confirm that integrated weed management (IWM) is superior to single approaches, as it provides season-long weed suppression, enhances resource-use efficiency, and improves overall crop performance. Therefore, IWM strategies, particularly intercultivation combined with manual weeding and selective herbicide use, should be promoted for sustainable soybean production systems.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Beam, S. C., Cahoon, C. W., Haak, D. C., Holshouser, D. L., Mirsky, S. B., & Flessner, M. L. (2021). Integrated weed management systems to control common ragweed (Ambrosia artemisiifolia L.) in soybean. *Frontiers in Agronomy*, *2*, 598426.

Caldas, J. V. d. S., Silva, A. G. d., Braz, G. B. P., Procópio, S. d. O., Teixeira, I. R., Souza, M. d. F., & Reginaldo, L. T. R. T. (2023). Weed competition on soybean varieties from different relative maturity groups. *Agriculture, 13*(3), 725. https://doi.org/10.3390/agriculture13030725

Chauhan, B. S. (2020). Grand challenges in weed management. *Frontiers in Agronomy, 1,* 3. https://doi.org/10.3389/fagro.2019.00003

Chauhan, B. S., Mahajan, G., Sardana, V., Timsina, J., & Jat, M. L. (2017). Productivity and sustainability of the rice–wheat cropping system in the Indo-Gangetic Plains of the Indian subcontinent: Problems, opportunities, and strategies. *Advances in Agronomy, 143,* 315–404.

Choudhary, A. K., Yadav, D. S., Sood, P., Rahi, S., Arya, K., Thakur, S. K., ... & Singh, R. (2021). Post-Emergence herbicides for effective weed management, enhanced wheat productivity, profitability and quality in North-Western Himalayas: A 'Participatory-Mode'Technology Development and Dissemination. *Sustainability*, *13*(10), 5425.

Dhanush, G., Geetha , K. N., Pruthviraj , N., Murali, K., Krishnamurthy , R., & Sinchana , J. K. (2025). Optimising weed control in sesame: insights into herbicide performance and crop productivity. *Plant Science Today*, *12*(3). https://doi.org/10.14719/pst.7083 (Original work published June 23, 2025)

Gajendra, K., Nooli, S., Nadagouda, B., & Vidyavathi, G. (2023). Integrated weed management in soybean [Glycine max (L.) Merrill]. *Journal of Farm Sciences*, *36*(04), 338-344.

Gerhards, R., Hüsgen, K., & Gehring, K. (2024). *Evaluation of mechanical and combined chemical with mechanical weeding in maize (Zea mays L.), soybean (Glycine max L.) and winter wheat (Triticum aestivum L.)*. *Plant, Soil and Environment, 70*(12), 751–759. https://doi.org/10.17221/386/2024-PSE

Gharde, Y., Singh, P. K., Dubey, R. P., & Gupta, P. K. (2018). Assessment of yield and economic losses in agriculture due to weeds in India. *Crop Protection, 107,* 12–18. https://doi.org/10.1016/j.cropro.2018.01.007

Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research* (2nd ed.). John Wiley & Sons.

Gupta, A., Singh, H., & Kumar, R. (2023). Impact of integrated weed management practices on yield and economics of soybean. *Journal of Oilseeds Research, 40*(3), 225–231.

Heap, I. (2014). Global perspective of herbicide-resistant weeds. *Pest Management Science, 70*(9), 1306–1315. https://doi.org/10.1002/ps.3696

Jin, H., Yang, X., Zhao, H., Song, X., Tsvetkov, Y. D., Wu, Y., ... & Zhang, J. (2023). Genetic analysis of protein content and oil content in soybean by genome-wide association study. *Frontiers in Plant Science*, *14*, 1182771.

Kaur, J., & Singh, B. (2021). Effect of weed management practices on growth and yield of soybean in Punjab. *Agricultural Reviews, 42*(1), 63–70.

Naithani, P., Kumar, A., Bahuguna, A., & Nain, P. (2025). Soybean Crop Management Under Rainfed Environment. In *Soybean Production Technology: Physiology, Production and Processing* (pp. 159-181). Singapore: Springer Nature Singapore.

Parven, A., Md Meftaul, I., Venkateswarlu, K., & Megharaj, M. (2025). Herbicides in modern sustainable agriculture: Environmental fate, ecological implications, and human health concerns. *International Journal of Environmental Science and Technology.* Advance online publication. https://doi.org/10.1007/s13762-024-05818-y

Pokhrel, A., Dangi, S. R., & Sharma, B. (2025). Response of Soybean and Weeds to Various Weed Management Practices. *Asian Journal of Advances in Agricultural Research*, *25*(7), 19-25.

Prashnani, M., Dupare, B., Vadrevu, K. P., & Justice, C. (2024). Towards food security: Exploring the spatio-temporal dynamics of soybean in India. *PloS one*, *19*(5), e0292005.

Ramesh, K., Matloob, A., Aslam, F., Florentine, S. K., & Chauhan, B. S. (2017). Weeds in a changing climate: Vulnerabilities, consequences, and implications for future weed management. *Frontiers in Plant Science, 8,* 95. https://doi.org/10.3389/fpls.2017.00095

Rudell, E. C., Zanrosso, B. A., Frandaloso, D., Giacomini, A. J., Spadotto, D. V., Vargas, L., ... & Santos, F. M. (2023). Integrated weed management strategies in a long-term crop rotation system. *Advances in Weed Science*, *41*, e020220053.

Saba, M. N., Ullah, M. J., Ali, M., Hossain, M. B., & Masum, S. M. (2023). The Manual, Chemical, Cultural, and Integrated Weed Management in Soybean Production. *SAARC Journal of Agriculture*, *21*(2), 195-206.

Sharma, D., Choudhary, J., Bharti, R., Sharma, A., & Prajapati, S. K. (2025). Effect of Intercropping and Herbicide-Based Weed

Management Strategies on Growth, Nutrient Uptake, Productivity and Profitability of Fodder Sorghum. *Journal of Advances in Biology & Biotechnology*, *28*(5), 819-829.

Sridhar, R., Longkumer, L. T., Singh, A. P., Gohain, T., Zion, G., Kikon, N., & Ao, I. (2025). Weed Management Strategies in Soybean: Assessing the Influence of Integrated Nutrient and Weed Management on Weed Dynamics and Dry Weight. International Journal of Economic Plants, 12(July, 4), 01–07

Swanton, C. J., & Weise, S. F. (1991). Integrated weed management: The rationale and approach. *Weed Technology, 5*(3), 657–663. https://doi.org/10.1017/S0890037X00027512

Vishwakarma, A. K., Meena, B. P., Das, H., Jha, P., Biswas, A. K., Bharati, K., ... & Patra, A. K. (2023). Impact of sequential herbicides application on crop productivity, weed and nutrient dynamics in soybean under conservation agriculture in Vertisols of Central India. *PloS one*, *18*(1), e0279434.

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