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Floristic List of Weeds in Irrigated *Sorghum bicolor* (Grain Sorghum) Fields in the El-Meilg Area, Gezira Scheme, Sudan

Mubarak Siddig Hamad [a*], Safia Abdullahi Abdelmageed Mohammed [b], Ahmed Saeed Kabbashi [c,d,e] and Kamalaldin Mahjoub Muhammed Gladeema [f]

[a] Phytochemistry and Taxonomy Department, Medicinal, Aromatic Plants and Traditional Medicine Research Institute (MAPTMRI), National Center for Research, Khartoum, Sudan.
[b] Biology Department, College of Science, Taibah University, Al Madinah Al Munawara, 42353, Saudi Arabia.
[c] Biomedical Science Department, Faculty of Pharmacy, Omar Al-Mukhtar University, Al-Bayda, Libya.
[d] Microbiology and Parasitology Department, Medicinal, Aromatic Plants and Traditional Medicine Research Institute (MAPTMRI), National Center for Research, Khartoum, Khartoum, Sudan.
[e] Microbiology Department, Faculty of Medical Laboratory Sciences, International University of Africa, Khartoum, Sudan.
[f] Sudanese Mineral Resources Co. (SMRC), Khartoum, Sudan.

Authors' contributions

This work was carried out in collaboration among all authors. Authors SAAM and KMMG designed the map and table and wrote the first draft of the manuscript. Authors MSH and ASK designed and analyzed the study, interpreted the results, prepared and wrote the manuscript. All authors read and approved the final manuscript.

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**Corresponding author: E-mail: mubaraksiddig23@yahoo.com;*

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ABSTRACT

Studies on weed flora are fundamental for the development of effective weed management strategies. This study provides the first comprehensive inventory of weed species in irrigated grain sorghum fields using the Sudan Gezira Scheme. Field surveys were conducted during the August-October 2025 growing season across multiple farms in the El-Meilg region. A visual inventory method was employed to record weed species, which were identified using regional flora and online taxonomic databases (Kew Plants of the World Online, IPNI). This study documented 39 weed species across 34 genera and 14 families. Dicotyledons were dominant (28 species), followed by the monocotyledons (11 species). The Poaceae family was the most species-rich (8 species), followed by Malvaceae (7 species), and Fabaceae (5 species). Most weeds were annual, with fewer annual/perennial and perennial species. Propagation was primarily by seeds (31 species), with other species reproducing via seeds and/or stolons (5 species), seeds and/or rhizomes (2 species), or a combination of all three (2 species). This study established a critical baseline database for developing targeted weed control protocols for Sudan's most important agricultural systems.

Keywords: Weed flora; Sorghum bicolor; Gezira scheme; Sudan; integrated weed management biodiversity.

1. INTRODUCTION

Weeds are plants that grow in undesirable locations and compete with crops for resources without human intervention. In agriculture, they significantly affect productivity by competing for light, water, and nutrients, harboring pests and diseases, and interfering with harvesting operations (Rahman, 2013).

The foundation of any successful weed management program lies in the precise identification and comprehensive understanding of weed species composition within a specific agro-ecosystem. Floristic studies have provided crucial insights into the biological characteristics, distribution patterns, and ecological dynamics of weed communities, enabling the development of targeted and sustainable control strategies (Monteiro and Santos, 2022, Chicouène, 2020). Without such fundamental knowledge, control measures may be ineffective, economically inefficient, or environmentally detrimental.

Sorghum bicolor (L.) Moench, or grain sorghum, is a vital cereal crop, ranking fifth globally. It is a key source of nutrition and bioactive compounds (Espitia-Hernández et al., 2022) and is crucial for food security in many developing countries because of its drought tolerance and low input requirements (Peerzada et al., 2017). In Sudan, sorghum is the principal crop, cultivated in approximately 55.6% of the total cultivated area, serving as a staple food and a primary livelihood source (Grenier et al., 2004).

The Gezira Irrigated Scheme is one of the largest agricultural projects in the world, playing a central role in Sudan's economy and food production. Sorghum is a key crop in this scheme and contributes significantly to the national output (Mamad, 2010). However, weed infestation remains a major constraint to sorghum production, with reported yield losses of up to 97% (Peerzada et al., 2017). Despite this significant threat, a systematic and detailed record of weed flora associated with grain sorghum in this pivotal agricultural scheme is lacking**.** Effective weed management begins with accurate identification and understanding of weed flora. This study provides the first dedicated inventory and ecological characterization of weeds in Gezira grain sorghum fields, aiming to establish a foundational database for future research and management strategies.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in the El-Meilg area, located in Gezira State, Al-Kamilin District, Sudan. This area has been a part of the Gezira Scheme since 1930. The climate is subtropical, characterized by hot summers (May to September) and cooler winters, where temperatures can drop to 12°C. The primary occupation of the area's approximately 20,000 inhabitants was farming.

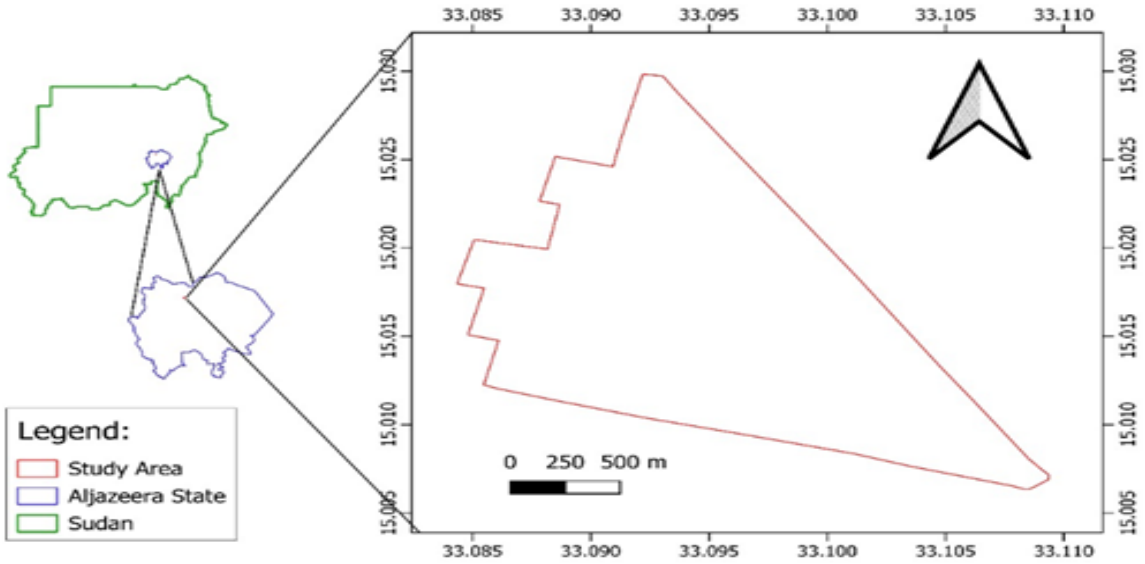

Fig. 1. A clear map illustrating the location of the El-Meilg area within the Gezira Scheme, Sudan

2.2 Field Survey and Weed Flora Inventory

Field surveys were conducted from August to October 2025 across ten randomly selected irrigated grain sorghum farms. A visual inventory technique was employed, supplemented by random quadrat sampling (1m x 1m quadrats, 10 per farm), to note the presence of species. Weed specimens were collected, photographed, and identified using regional floras (Abdallah et al., Karar, 2003), the online databases Plants of the World Online (POWO, 2023) and the International Plant Names Index (IPNI, 2020). The data recorded for each species included the following:

1) Updated botanical name and family.
2) Botanical class (Dicot./Monocot.).
3) Local vernacular name (collected from local farmers).
4) Growth form (Erect, Prostrate, and Vine).
5) Life span (Annual, Perennial, Biennial).
6) Primary means of propagation (Seed, Stolons, Rhizomes).

3. RESULTS AND DISCUSSION

A floristic survey recorded 39 weed species belonging to 34 genera and 14 families (Table 1). Dicotyledonous species constituted the majority (71.8%, 28 species), whereas monocotyledonous species accounted for 28.2% (11 species). The most represented families were Poaceae (8 species), Malvaceae (7 species), and Fabaceae (5 species).

3.1 Life Form and Growth Strategy

Annual herbs (AnH) were the most prevalent life forms. Erect growth was the dominant form, followed by the prostrate and vine forms.

3.2 Propagation Methods

The majority of species (31 species, 79.5%) were propagated solely by seeds. Other propagation strategies included seeds and/or stolons (5 species), seeds and/or rhizomes (2 species), and a combination of seeds, stolons, and rhizomes (2 species).

This study provides a critical insight into the weed communities of irrigated grain sorghum in the Gezira Scheme. The recorded 39 species across 14 families indicate relatively high biodiversity within the agro-ecosystem, which could have implications for both competition with the crop and the overall ecological resilience of the system. The dominance of dicotyledonous weeds suggests that broadleaf-specific herbicides and cultural practices should be the primary focus of weed control programs, although the significant presence of grass weeds, particularly from the Poaceae family, necessitates an integrated management approach to prevent a shift in weed flora towards more difficult-to-control grass species.

Table 1. Weed Species Inventory in Irrigated *Grain Sorghum* Fields, El-Meilg Area

Family	Weed Species	Botanical Class	Local Name(s)	Growth Form	Life Span	Propagation Method
Amaranthaceae	*Digera muricata* (L.) Mart.	Dicot.	Lablab	Erect	AnH	Seed
Aizoaceae	*Trianthema portulacastrum* L.	Dicot.	Rabaa	Prostrate	AnH	Seed
Aristolochiaceae	*Aristolochia bracteolate*Lam	Dicot.	Um-galagel	Prostrate	PeH/AnH	Seed
Asteraceae	*Eclipta prostrata* (L.) L	Dicot.	Tamer al-ganam	Erect/Prost	AnH/PeH	Seed
	Sonchus oleraceus L.	Dicot.	Molita	Erect	AnH/PeH	Seed
	Xanthium brasilicum Vell.	Dicot.	Shelni-maak	Erect	AnH	Seed
Commelinaceae	*Commelina kotschyi* Hassk	Monocot.	Ibrik-Al.faki	Prostrate	PeNgr	Stolon/Seed
	Cyanotis axillaris (L.) D.Don ex Sweet	Monocot.	Ibrik-Al.faki	Prostrate	AnNgr	Stolon/Seed
Convolvulaceae	*Ipomoea cordofana* Choisy	Dicot.	Hantot / tabaar	Prostrate	PeH	Seed
	Merremia emarginata (Burm.f.) Hallier f.	Dicot.	N/R	Prostrate	PeH	Seed
	Momordica balsamina L.	Dicot.	N/R	Vine	AnH	Seed
	Ipomoea sp.	Dicot.	N/R	Vine	AnH	Seed
Cyperaceae	*Cyperus rotundus* L.	Monocot.	Sedaa	Erect	PeSed	Rhizome/Seed
Euphorbiaceae	*Phyllanthus maderaspatensis*L.	Dicot.	Soreeb-kabeer	Erect	AnH	Seed
	Phyllanthus niruri L.	Dicot.	Soreeb	Erect	AnH	Seed
Fabaceae	Alysicarpus monilifer (L.) DC.	Dicot.	Fola	Prostrate	AnH/PeH	Seed
	Phaseolus trilobus Aiton	Dicot.	Alaf	Vine	AnH	Seed
	Rhynchosia minima (L.) DC.	Dicot.	Adan al-far	Vine	AnH/PeH	Seed
	Senna obtusifolia (L.) H.S.Irwin & Barneby	Dicot.	Kawal	Erect	AnH/PeH	Seed
	Sesbania sesban (L.) Merr.	Dicot.	Sisaban	Erect	PeSh	Seed
Lamiaceae	*Ocimum basilicum* L.	Dicot.	Rihan	Erect	PeH	Seed
Malvaceae	Abelmoschus sp.	Dicot.	Bamiaa	Erect	AnSh	Seed
	Abutilon pannosum var. pannosum	Dicot.	Grgadan/hanbok	Erect	AnSh	Seed
	Corchorus fascicularis Lam.	Dicot.	Khodrat al-khala	Erect	AnH	Seed
	Corchorus tridens L.	Dicot.	Khodrat al-khala	Erect	AnH	Seed
	Hibiscus obtusilobus Garcke	Dicot.	N/R	Erect	AnH	Seed
	*Hibiscus panduriformis*Burm.f.	Dicot.	Handbook/um-Baro	Erect	AnH/PeH	Seed

Family	Weed Species	Botanical Class	Local Name(s)	Growth Form	Life Span	Propagation Method
	Hibiscus trionum L.	Dicot.	Karkauba	Erect	AnH/PeH	Seed
Orobanchaceae	*Striga hermonthica* (Delile) Benth.	Dicot.	Bodaa	Erect	AnH	Seed
Poaceae	*Brachiaria eruciformis* (Sm.) Griseb.	Monocot.	Um-kweaat	Erect	PeGr	Stolons/Seed
	Cynodon dactylon (L.) Pers.	Monocot.	Nagela	Erect	PeGr	Stolons/Seed
	Dactyloctenium aegyptium (L.) Willd.	Monocot.	Um-asabee	Erect	AnGr	Rizomes/Stolon/Seed
	Dichanthium annulatum (Forssk.) Stapf.	Monocot.	Dankog	Erect	PeGr	Rizomes/Stolon/Seed
	Dinebra retroflexa (Vahl) Panz.	Monocot.	Um-melaha	Erect	AnGr	Rizomes/Seed
	Echinochloa colona(L.) Link	Monocot.	Defera	Erect	AnGr	Stolons/Seed
	Eragrostis iscose (Retz.) Trin.	Monocot.	Aish-alfar	Erect	AnGr/PeGr	Seed
	Urochloa panicoides P.Beauv.	Monocot.	N/R	Erect	AnGr	Seed
Solanaceae	*Physalis angulata* L.	Dicot.	Fronta	Erect	AnH	Seed
	Solanum dubium Fresen.	Dicot.	Gobeen	Erect	PeH	Seed

Key: N/R: Not Recorded; AnH: Annual Herb; PeH: Perennial Herb; AnGr: Annual Grass; PeGr: Perennial Grass; AnNgr: Annual Non-grass; PeNgr: Perennial Non-grass; PeSed: Perennial Sedge; PeSh: Perennial Shrub; AnSh: Annual Shrub.

The floristic composition revealed in this study reflects the unique agro-climatic conditions of the Gezira Scheme. The high prevalence of families such as Poaceae and Malvaceae is consistent with other irrigated systems in semi-arid regions, where disturbance from agricultural practices and available moisture creates a favorable environment for species with rapid growth cycles and high seed production (Karar et al., 2005, Harker and O'Donovan, 2013). The specific combination of species, however, serves as a unique fingerprint for this system, underscoring the necessity of local-level studies that rely solely on regional data.

The prevalence of annual species (e.g., *Digera muricata* and *Echinochloa colona*) is a common finding in agro-ecosystems and is often linked to their reliance on high seed production and the formation of persistent seed banks, ensuring their survival and spread across seasons (Monteiro and Santos, 2022). This highlights a critical management priority: disrupting the seed-bank cycle. Strategies such as crop rotation with smoother crops, stale seedbed techniques, and consistent pre-emergence herbicide applications are essential to deplete this bank over time. The high diversity within the Poaceae, Malvaceae, and Fabaceae families aligns with the findings from other agricultural systems in semi-arid regions.

Understanding the propagation methods is crucial for devising effective control strategies. The dominance of seed-propagated annuals highlights the importance of preventing seed set through timely weeding. However, the presence of perennial species that propagate vegetatively, such as *Cynodon dactylon* (stolons) and *Cyperus rotundus* (rhizomes), is concerning. These species represent a long-term management challenge, as their underground storage organs allow them to escape control measures that target aboveground growth. However, application of a single post-emergence herbicide is often insufficient. Effective management requires a concerted effort combining deep tillage, where feasible, competitive sorghum cultivars, and the use of systemic herbicides that translocate to destroy perennial structures (Chicouène, 2020).

Furthermore, identification of the parasitic weed *Striga hermonthica* warrants special attention. Its presence signals a severe threat to sorghum production and can cause total crop failure in heavily infested fields. Its management is complex and should be proactive, integrating resistant sorghum varieties, chemical seed treatments with herbicides such as imazapyr, and cultural practices such as intercropping with trap crops to induce suicidal germination (Dawoud, 1995). The potential of *Rhynchosia minima*, documented in this study, to serve as a trap crop is a promising finding that merits immediate field validation.

Although often viewed as detrimental, weeds can play complex ecological roles. The documented Fabaceae species (e.g., *Rhynchosia minima* and *Phaseolus trilobus*) can contribute to soil health by fixing atmospheric nitrogen. Furthermore, some species, such as *R. minima* have been reported to induce "suicidal germination" in *Striga hermonthica* (Dawoud, 1995), suggesting their potential use in bio-control strategies. This introduces a nuanced perspective to weed management, where certain species could be tolerated or even managed to harness their ecological benefits, moving towards a more holistic approach to agro-ecosystem management. Several species, including *Aristolochia bracteolata* and *Senna obtusifolia*, are known for their medicinal uses in Sudan (Hegazy et al., 2020, Musa et al., 2011), indicating their socio-economic value beyond agriculture.

While this study provides a foundational inventory of weed species in grain sorghum fields, it is important to note its limitations. The reliance on a visual inventory and the absence of quantitative ecological metrics restrict the ability to assess the relative dominance and economic impact of individual weed species. Furthermore, the study was conducted over a single growing season and within a specific locality, which may not fully capture the temporal and spatial variability of the weed flora. Future investigations should build on this baseline by employing quantitative metrics to identify key problematic species and their threshold levels. Research should also focus on evaluating the efficacy of specific Integrated Weed Management (IWM) strategies tailored to this flora, such as the sequencing of herbicides, use of sorghum cultivars with competitive traits, and practical integration of bio-control agents such as *R. minima*.

4. CONCLUSION

This study provides the first comprehensive floristic inventory of weeds in irrigated grain sorghum fields within Sudan's Gezira Scheme, identifying 39 species predominantly comprising annual, seed-propagated dicotyledons. To translate these findings into actionable outcomes, it is recommended that farmers and agricultural extension services prioritize the targeted control of perennial grasses and sedges, such as *Cyperus rotundus*, through deep tillage and systemic herbicides, while implementing pre-emergence herbicides to manage the abundant annual weed seed bank. Furthermore, researchers should build on these baseline data by incorporating quantitative ecological metrics to identify the most competitive species and explore integrated weed management strategies that combine chemical, cultural, and biological controls tailored to this specific agro-ecosystem.

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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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