

Weed management strategies for sugarcane: A look into popular practices and innovations

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Sugarcane is one of the most important commercial crops cultivated worldwide and serves as a major source of sugar, biofuel, and other value-added products. Owing to its long duration, weed infestations pose a major challenge to economically viable sugarcane cultivation. Presence of weeds may lead to substantial yield losses ranging from 12–72 percent. Factors such as wider row spacing, long duration of crop and delayed germination create favourable conditions for weed invasion. To address this issue, efficient weed management strategies are crucial for maximising sugarcane yield sustainably. This article explores popular practices and innovations, including physical and chemical methods, cultural management, and preventive measures, aiming to strike a balance between weed control and environmental protection to meet the increasing global demand for sugar.

Keywords: Sugarcane, Sustainable cultivation, Weed control strategies, Yield losses

SUGARCANE (*Saccharum officinarum*) is a significant cash crop that contributes to the agricultural business worldwide, serving as primary source of sugar and other valuable products. It is an important long duration C4 crop adaptable to both tropical and sub-tropical areas. After Brazil, India is the second-largest producer, providing 468.79 million tonnes (mt) of millable cane and 352 mt of sugar production (MoAFW 2022-23). Weeds are unwanted plants that thrive alongside the desired crop, and have a negative impact because of a number of reasons, including nutrient loss, shade, allelopathy, and disease transmission. Wider row spacing, prolonged crop duration, slow initial growth, and delayed canopy development create favourable conditions for severe weed infestation in sugarcane fields. If these aggressive invaders are not stopped, sugarcane development could be significantly hampered, costing farmers and other stakeholders a significant amount of money. Increasing demand for sugar and its by-products has

intensified the need for efficient and sustainable sugarcane production systems. Adopting efficient weed management solutions that strike a balance between weed control and environmental protection is essential if we are to meet this demand sustainably and make sugarcane cultivation a profitable venture.

Losses due to weeds

In sugarcane, due to various climatic, edaphic, and biotic conditions, there are different types and numbers of weed species are

found. Weed infestation may cause cane yield losses ranging from 12–72% depending upon weed flora, crop stage, and management practices. Twinning weeds such as *Ipomoea* spp. and *Convolvulus* spp. further increase harvesting difficulties and cultivation costs, ultimately reducing cane and sugar yield.

Critical period of crop-weed competition in sugarcane

Sugarcane is a long duration crop and germination continues for about one month. Therefore, it is

Table 1. Weed flora found in sugarcane

Classification of weeds	Weed species found
Annual green weeds	<i>Commelina benghalensis</i> , <i>Eleusine indica</i> , <i>Setaria glauca/verticillate</i> , <i>Echinochloa colona</i> , <i>Brachiaria</i> spp., <i>Dactyloctenium aegyptium</i> , <i>Digitaria sanguinalis</i>
Annual broad-leaved weeds	<i>Amaranthus viridis</i> , <i>Ageratum conyzoides</i> , <i>Acanthospermum hispidum</i> , <i>Celosia argentea</i> , <i>Digera arvensis</i> , <i>Euphorbia hirta</i> , <i>Phyllanthus niruri</i> , <i>Leucas aspera</i> , <i>Parthenium hysterophorus</i> , <i>Portulaca oleracea</i> , <i>Solanum nigrum</i>
Perennial weeds	
Grasses	<i>Cynodon dactylon</i> , <i>Saccharum spontaneum</i> , <i>Sorghum halepense</i>
Sedges	<i>Cyperus rotundus</i>
Broad leaved weeds	<i>Convolvulus arvensis</i> , <i>Ipomoea</i> spp., <i>Launaea</i> spp.
Parasitic weeds	<i>Striga</i> , <i>Aeginetia indica</i>

heavily infested with weeds from planting to establishment of crop i.e. 4–5 months after planting and this period is known as the critical period of crop-weed competition (CPCWC) for sugarcane crop, where removal of weeds results in higher yield and economic returns. On the other hand, weeds emerging later do not interfere much on the production of sugarcane. In a sugarcane field, where the purple nut sedge (*Cyperus rotundus*) is a predominant weed species, crop-weed competition started even at the initial sugarcane sprouting stage. However, the purple nut sedge is very sensitive to sugarcane canopy shading and low temperature, thereby, weed competition declines after 22 days due to canopy shading and reduced light penetration.

Conventional weed management

Weed control is the technique of reducing weed infestation to allow for profitable crop growth and production. By implementing different well-known weed control strategies, sugarcane weeds can be managed efficiently.

Preventive measures: Field sanitation practice must be taken care during entire crop cycle, and rotational cropping sequence by keeping neighbouring canals/ditches weed free, clean equipment, and incorporation of fallow period.

Mechanical measures: Mechanical weed management remains an important component of integrated weed management, particularly under labor-intensive sugarcane cultivation systems.

- Hand weeding or hand hoe in flatbed planting and in furrows of ridge furrow planting can be done as spacing is between rows is less. However, junior hoe can be utilised along the ridges for removing weeds at 25, 55 and 85 days after planting (DAP).
- Power tiller fitted with tines/rotavator can be used for intercrops weed removal in widely spaced planting methods such as paired row and trench planting of sugarcane.
- Trash mulching on ridges

or between two paired rows uniformly with cane trash to a thickness of 10 cm within a week after planting helps to reduce weed population. Mulch the field with trash after 21 DAP.

Cultural management:

- Intercropping with legume cover crops which are of short duration and quick growing like green gram, black gram in spring and *Sesbania* in autumn.
- Drip irrigation in the paired row planting of sugarcane is also helpful to avoid weeds in between two paired row gaps.
- Irrigation before sowing maintains moisture in field and helps in an increase in germination and reduce density of weeds (stale seed bed approach) particularly that of *Cyperus rotundus* at early stages.
- Hoeing must be done 2–3 weeks (15–20 DAP) planting of crop before application of irrigation. It helps in removal of early weeds and helps in higher emergence of the crop. Depth of hoeing should be 6–8 cm.
- After the hoeing and complete germination of the crop, mulching should be done in between the two rows of sugarcane.

Chemical method: Chemical method of weed control is easier, cheaper, less time consuming than hand weeding. Rotation of herbicides with different modes of

action is essential to minimise the development of herbicide-resistant weed populations.

- Pre-emergence application of herbicide is carried 3–4 DAP as a blanket spray with atrazine 50% WP @ 1.25–2.0 kg a.i./ha, oxyfluorfen 750 mL a.i./ha or 2,4-D @ 2.5 kg a.i./ha for sole sugarcane crop. It selectively manages annual grasses and broadleaf weeds. Its effectiveness depends on adequacy of soil moisture at planting; therefore, maintain good moisture level at planting.
- To manage the majority of broad-leaved weeds, post-emergence herbicide applications of tank mixture of metribuzin 70% WP (0.5 kg a.i./ha) and 2,4-D amine salt 58% WP (1.0 kg a.i./ha) sprayed at 40–50 days after planting is widely used and very successful practice. Also, post-emergence herbicide applications of tank mixture of metribuzin 700 g + halosulfuron 90 g a.i./ha can be practice.
- To combat twining weeds such as *Ipomoea* spp. and *Convolvulus* spp. application of atrazine 50% WP (1.0 kg a.i./ha) or metribuzin 70% WP (1.0 kg a.i./ha) can be made between the cane rows following earthing.
- Post-emergence application of halosulfuron-methyl @ 65–130 g a.i./ha may effectively manage *Cyperus rotundus* infestation during early crop stages.

Table 2. Reasons for weeds infestation associated with planting methods

Methods of sugarcane planting	Reasons for weeds infestation
Flat bed planting	• Wide spacing of 75–90 cm between the rows. • Shallow opening of furrow (8–10 cm) brings weed seeds to the upper surface. • Early germination of weeds due to adequate and uniform moisture on upper soil surface. • Slow canopy development of sugarcane.
Trench and pit planting	• Wider spacing of 90–120cm between the rows/pits. • Early irrigations provided to support germination as well as weed emergence. • Canopy development of sugarcane is slow and do not cover the land completely.
Paired row planting	• 30–60 cm spacing between two lines with 120 cm gap between two paired rows leads to heavy infestation of weeds especially between the rows.
Ridge and furrow planting	• V shaped furrows about 80–100cm apart and 20–25 cm deep. • Deep digging brings up weed seed bank on the soil surface.

Ecological risks with herbicides

Soil degradation: Accumulation of chemicals like atrazine kills beneficial microbes and earthworms, disrupting nutrient cycling and long-term fertility.

Water contamination: Persistent residues leach into groundwater and runoff into rivers, poisoning aquatic life and damaging sensitive ecosystems like coral reefs.

Reduced biodiversity: Non-target plants and pollinators are harmed, leading to a monoculture environment with lower natural resilience.

Superweed evolution: Constant chemical pressure creates herbicide-resistant weeds, forcing farmers to use even harsher, more toxic chemicals.

Food chain risks: Residual chemicals can accumulate in local flora and fauna, posing long-term health risks to the broader food web.

Herbicide resistance issues in weeds

Herbicide resistance in sugarcane is an escalating global issue driven by intensive, long-term reliance on specific chemical modes of action for weed control. This reliance threatens crop sustainability through increased weed control costs, the need for alternative chemicals, and the threat of herbicide-resistant volunteer sugarcane plants. Common herbicide-resistant weeds in sugarcane are:

Goosegrass (*Eleusine indica*): This species has evolved resistance to multiple herbicides, including glyphosate and paraquat, making it one of the most difficult grasses to manage globally.

Italian ryegrass (*Lolium multiflorum*): Populations in some regions, such as Louisiana, have developed high-level resistance to paraquat, requiring up to 16 times the maximum labeled rate for control.

Jungle rice (*Echinochloa colona*): Frequently shows resistance to glyphosate and certain ACCase inhibitors, complicating grass management in tropical regions.

Horseweed and waterhemp: While broader row-crop weeds, they

are increasingly found in sugarcane systems showing resistance to both Group 2 (ALS inhibitors) and glyphosate.

Integrated approaches

Integrated Weed Management (IWM) in sugarcane involves a strategic combination of various techniques to effectively control weed growth while promoting sustainable and productive agriculture. Integration of cultural, mechanical, and chemical methods offers long-term, sustainable, and economically viable weed management in sugarcane. One key approach is paired row planting, where sugarcane is cultivated in pairs allowing for manual or chemical control of weeds within the narrow spaces between rows. Additionally, the spaces between pairs are ploughed using small weeders, ensuring thorough weed elimination. Intercultural operations are implemented to enhance soil aeration, remove old roots, and tackle persistent weeds resistant to chemicals. This holistic approach not only prevents weed-related yield losses but also minimises the development of herbicide-resistant weed species, ensuring the long-term success of sugarcane farming. Farmers get benefitted from increased yields and reduced dependency on herbicides, leading to environmentally friendly and economically viable sugarcane cultivation practices. IWM not only boosts crop productivity but also contributes significantly to sustainable agriculture and

environmental conservation.

Sustainable and advanced approaches

New approaches to weed management in sugarcane focus on diversifying control mechanisms to break the cycle of herbicide resistance and reduce chemical reliance.

Bioherbicides and microbial agents: Bioherbicides leverage living organisms or their natural metabolites to suppress weeds.

Fungal pathogens: Agents like *Plectosporium alismatis* are being researched as biocontrol agents to manage resistant weeds.

Synergistic use: Combining bioherbicides with synthetic herbicides has shown to significantly reduce the required chemical dosage while increasing overall suppression.

Microbial metabolites: Products derived from plant pathogens provide shorter environmental persistence and multiple modes of action which helps delay in developing resistance.

Allelopathy: Natural suppression of weeds

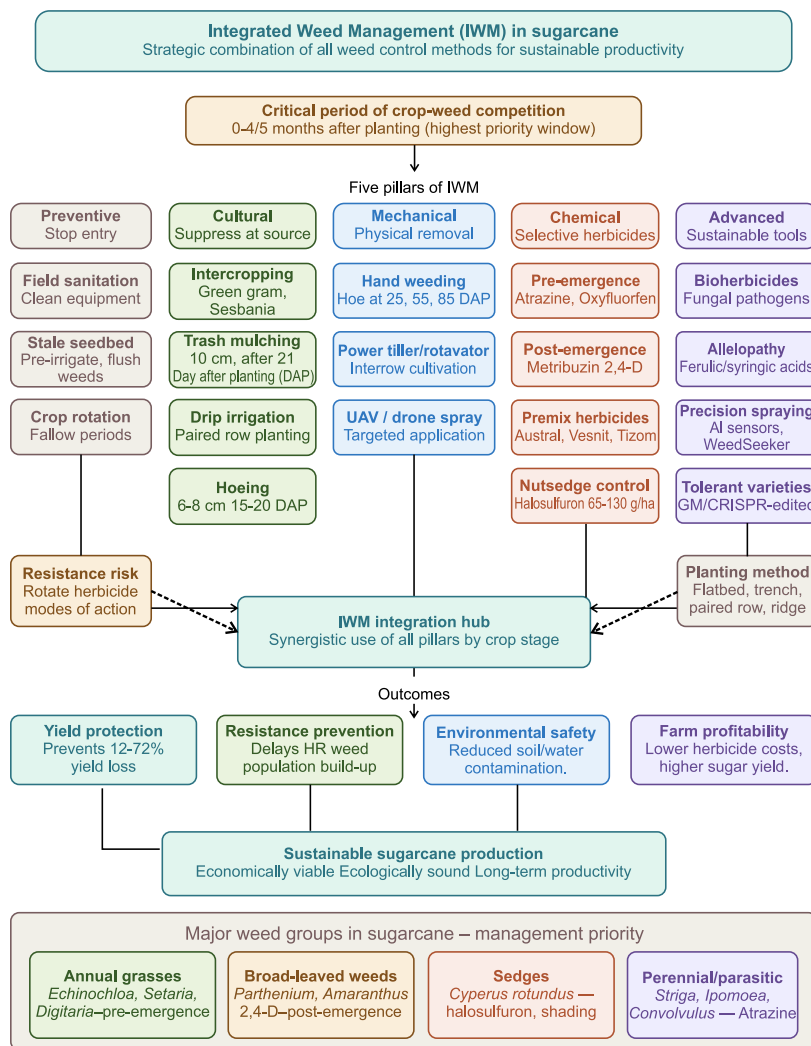
Allelopathy involves the use of allelochemicals released by plants to inhibit the growth of surrounding weeds.

Sugarcane leaf litter: Trash blanketing (mulching) with leaf litter physically blocks weeds and releases inhibitory compounds like ferulic and syringic acids.

Aqueous leaf extracts: Research shows that crude extracts from sugarcane leaves, particularly acidic fractions, can completely inhibit the

Table 3. Advanced herbicide premixes with different mode of action

Premix product	Active ingredients	Timing	Key features
Austral	Clomazone + Metribuzin	Pre-emergence	Dual MOA for broad-spectrum grass and broadleaf control.
Vesnit Complete	Topramezone + Atrazine	Post-emergence	Targets complex weed flora with high yield safety.
Tizom	Halosulfuron Methyl + Metribuzin	Early post emergence	Effective against <i>Cyperus rotundus</i> (Nutsedge) and grasses.
Trishuk	2,4-D + Metribuzin + Chlorimuron	Post-emergence	A 3-way mix for complete control of diverse weed populations.
Uttam MesoTrine	Mesotrione + Atrazine	Early post emergence	Combines pigment inhibitors and PSII inhibitors.



for targeted, autonomous spraying even in mature sugarcane fields where ground machinery cannot enter.

Although precision spraying technologies and UAV-based herbicide application are emerging tools, their adoption in India is currently limited due to high operational costs and small landholdings.

SUMMARY

Effective weed management is essential for sustaining sugarcane productivity and profitability under changing agricultural conditions. Since the crop remains vulnerable to weed competition during the early growth period, timely adoption of integrated weed management practices involving cultural, mechanical, and judicious chemical approaches is necessary. Sustainable strategies such as trash mulching, intercropping, precision herbicide application, and herbicide rotation can reduce weed pressure while minimising ecological risks and herbicide resistance. Therefore, an integrated and location-specific weed management approach will play a crucial role in enhancing sugarcane productivity, environmental sustainability, and long-term farm profitability in India.

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germination of major weeds like *Amaranthus viridis*.

Perennial root exudates: Older sugarcane roots release acids and enters into the rhizosphere that can naturally inhibit co-occurring weeds such as *Bidens pilosa*.

Advanced precision strategies

Precision spot-spraying: Using sensors and AI to detect and spray weeds (e.g. WeedSeeker) can reduce herbicide usage and cost.

UAV (Drone) application: Drones like the DJI Agras T20 allow

Textbook on Environmental Pollution



This textbook provides a comprehensive overview of environmental pollution and its management. It systematically examines air, water, and soil pollution; the risks associated with heavy metals and hazardous substances; the growing challenge of solid waste; and the often-overlooked impacts of noise pollution. Emphasis is placed on recent scientific developments, modern monitoring techniques, innovative remediation strategies, and practical control measures that support environmental protection.

TECHNICAL ASPECTS

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