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7. Weed Management in Millets

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Abstract:

As the nutritional significance of millets continues to be recognized, substantial backing for their cultivation has been provided through both national and international policies. Millets, predominantly grown in rain fed conditions and nutrient-deficient soils, face the risk of yield losses due to intense weed competition. The presence of grasses, sedges, broad-leaved weeds, and the parasitic weed Striga contributes to yield reductions ranging from 15% to a staggering 97% in millet crops. Timely and effective weed management during the critical 15-42-day period after sowing is imperative. Given the limited availability of selective herbicides, especially for minor millets, weed management in millets heavily relies on cultural and mechanical methods. An integrated approach, incorporating strategies such as cultivating weed-competitive crop varieties, optimizing spacing, applying appropriate fertilizer doses and placements, implementing mulching with crop residues, adopting inter-cropping techniques, employing cultural and mechanical practices, and judiciously using herbicides, is essential for achieving optimal weed management and maximizing millet crop yields. Addressing Striga infestations requires a comprehensive approach involving the use of resistant varieties, crop rotation, catch crops, and judicious herbicide application.

The exploration of herbicide-resistant varieties further enhances the potential for effective weed and Striga management, emphasizing the need for a multifaceted and adaptive approach in safeguarding the productivity of these vital crops.

Keywords:

Millets, Sorghum, Pearl millet, Finger millet, Kodo millet, Barnyard millet, Foxtail millet, Striga, Weed management.

7.1 Introduction:

The multifaceted importance of weed management in millets extends beyond mere agricultural productivity, impacting critical dimensions such as food security, economic stability, and environmental sustainability. Millets, renowned for their adaptability to diverse agro-ecological zones, emerge as a valuable alternative for farmers grappling with challenges posed by climate variability and resource limitations. Uncontrolled weeds, if left unchecked, not only engage in resource competition with millet crops for essentials like water, nutrients, and sunlight but can also act as hosts for pests and diseases.

Therefore, effective weed management presents itself as a comprehensive strategy that transcends immediate yield protection, addressing the broader health of the agroecosystem.

In the absence of selective herbicides tailored for minor millets, cultural and mechanical methods assume a pivotal role in weed control strategies. This involves cultivating millet varieties inherently competitive against weeds, adjusting planting spacing to alleviate weed pressure, and optimizing fertilizer application to promote robust millet growth. Incorporating mulching with crop residues serves the dual purpose of suppressing weed growth and enhancing soil moisture retention and nutrient availability. Intercropping millets with compatible crops adds another layer of disruption to weed development, contributing to sustainable agroecosystem management. Furthermore, any judicious use of herbicides, where applicable, must align with an integrated weed management framework. This requires a nuanced understanding of specific weed species, their life cycles, and the potential impact of herbicides on non-target organisms and the environment.

As the demand for millets rises due to their nutritional benefits and adaptability, implementing effective weed management practices becomes pivotal for ensuring the long-term success of millet cultivation and fostering resilient agricultural systems. Beyond the immediate agricultural context, the impact of successful weed control extends to the socioeconomic landscape of farming communities. By ensuring stable and profitable yields, weed management safeguards the livelihoods of farmers, contributing to the overall economic resilience of rural areas. Millets, gaining recognition as nutri-cereals, witness a growing market demand due to their nutritional value and suitability for diverse culinary applications. Consequently, effective weed management positions farmers to meet market requirements, fostering economic sustainability and enhancing the socioeconomic well-being of communities engaged in millet cultivation. Environmental sustainability stands as another critical dimension intertwined with weed management in millets. By minimizing reliance on synthetic herbicides and prioritizing cultural and mechanical methods, farmers contribute to preserving soil health and biodiversity. Sustainable weed management practices, including cover cropping and agro ecological diversification, not only control weeds but also promote ecological balance, reduce the environmental footprint of agriculture, and enhance the long-term resilience of farming systems. In a world increasingly focused on sustainable agriculture, weed management in millets emerges as a pivotal element in constructing resilient, environmentally friendly, and socially responsible food production systems.

Despite the considerable yield potential of certain small or minor millets such as finger millet, kodo millet, and barnyard millet, their productivity remains relatively low. This discrepancy underscores the need for concerted efforts aimed at increasing productivity through the development and adoption of superior genotypes and improved management practices. Cultivating millets, however, presents a myriad of challenges, with biotic constraints, particularly weeds, standing out as major impediments.

Therefore, a comprehensive understanding of the nature of weed-related issues and exploration of viable management options becomes imperative. This paper aims to contribute to this understanding by reviewing recent information on various aspects of weed management in millets. This chapter is expected to shed light on the current state of knowledge regarding weed-related challenges faced by millet cultivation.

By examining recent developments and insights in weed management strategies, the paper seeks to offer valuable perspectives that can inform future research directions and practical interventions. The ultimate goal is to enhance the productivity and sustainability of millet cultivation, acknowledging the pivotal role that effective weed management plays in achieving these objectives. The synthesis of recent information on weed management in millets presented in this paper is poised to contribute to the ongoing discourse on optimizing agricultural practices for small millets and addressing the broader challenges associated with their cultivation.

Table 7.1: Diversity in Millets

Crop	Scientific name	Origin	Chromosome number
Sorghum	Sorghum bicolour	North Eastern Africa	2n=2x=20
Pearl Millet	Pennisetum glaucum	West Africa	2n=2x=14
Finger Millet	Eleusine coracana	East Africa, India	2n=4x=36
Foxtail Millet	Setaria italic	Eastern Asia	2n=2x=18
Proso Millet	Panicum miliaceum	Egypt and Arabia	2n=4x=36
Barnyard Millet	Echinochloa frumentacea, E. utilis	India, Japan	2n=6x=54
Little Millet	Panicum sumatrense	Southeast Asia	2n=4x=36

7.2 Weed Flora Infesting Millets:

Millets are typically cultivated during the rainy season, promoting the vigorous growth of weeds. Various types of weeds, including grasses, sedges, and broad-leaved varieties, infest millet crops during their initial growth phase (Table 7.2). The extent of weed flora infestation and their competition intensity with the crops vary based on geographic regions, soil and weather conditions, as well as field and crop management practices (Stahlman and Wicks 2000; Mashingaidze *et al*. 2012).

Grasses such as *Echinochloa colona* (jungle rice), *Echinochloa crus-galli* (barnyard grass), *Eleusine indica* (goose grass), *Digitaria sanguinalis* (crab grass), and *Sorghum halepense* (johnson grass) are common, while broad-leaved weeds such as *Amaranthus palmeri* (Palmer amaranth), *A. retroflexus* (Redroot pigweed), *Celosia argentea* (white cock's comb), *Trianthema portulacastrum* (horse weed), *Tribulus terrestris* (puncture vine), *Boerhaavia diffusa* (hog weed), *Acanthospermum hispidum* (Bristly starbur), and sedges like *Cyperus rotundus*, as well as *Striga asiatica* and *S. hermonthica* (Witch weed) are prevalent worldwide as the most common weeds affecting millets.

In sorghum, grasses such as *Echinochloa*, *Panicum*, *Digitaria*, and *Sorghum halepense* are considered the most common and troublesome weeds (Limon-Ortega *et al*. 1998; Peerzada *et al.* 2017). Carpetweed (*Trianthema portulacastrum*) was reported as the predominant weed (over 28%) in pearl millet crops (Deshveer and Deshveer 2005).

Girase *et al*. (2017) documented grassy weeds like *Cynodon dactylon, Brachiaria eruciformis*, broad-leaved weeds like *Parthenium hysterophorus, Commelina benghalensis, Celosia argentea, Panicum isachne, Amaranthus viridis, Euphorbia microphylla, Phyllanthus niruri, Alternanthera triandra*, and sedge *Cyperus rotundus* in pearl millet. In the U.S. central Great Plains, Reddy *et al*. (2014) identified Canada thistle, kochia, redroot pigweed, green foxtail, and palmer amaranth as the most common troublesome weeds affecting millet crops. Striga, a parasitic weed, poses a significant biotic constraint, causing considerable damage to millet crops in the semi-arid tropics. Striga hermonthica is particularly problematic in the dry savannas of sub-Saharan Africa, with higher infestation rates reported in Nigeria compared to other West African countries, where approximately 80% of sorghum-cropped land is affected by this weed (Mamudu *et al*. 2019).

Table 7.2. Major Weeds in Millet Crops

Crop	Major weeds
Sorghum	Scop., *Echinochloa crus-galli* (L.) P. Beauv., *Sida spinosa* (L.), *Urochloa platyphylla* (Nash.), and *Senna*
	obtusifolia (L.) Irwin and Barne
	Echinochloa crus-galli, Cynodon dactylon, Sorghum halepense, Digitaria sanguinalis, Amaranthus viridis,
	Alternanthera pungens, Digera arvensis, Convolvulus arvensis, Vernonia cinerea, Eclipta alba, Trianthema
Pearl millet	*portulacastrum, Euphorbia hirta, Physalis minima* and *Cyperus rotundus*
	Trianthema portulacastrum, Tribulus terrestris, Cyperus rotundus, Amaranthus viridis, Amaranthus spinosus,
	Cyperus compressus, Euphorbia spp., *Echinochloa colona* and *Cynodon dactylon*
	Cynodon dactylon, Echinochloa crus-galli, Brachiaria ramosa, Eluropus villosus, Amaranthus viridis, Digera
	arvensis, Euphorbia hirta, Boerhaavia diffusa, Acanthospermum hispidum, Commelina benghalensis, Portulaca
	oleracea and *Cyperus rotundus*
	Cynodon dactylon, Brachiaria eruciformis, Parthenium hysterophorus, Commelina benghalensis, Celosia
	argentea, Panicum isachne, Amaranthus viridis, Euphorbia microphylla, Phyllanthus niruri, Alteranthera
	triandra and *Cyperus rotundus*
Finger millet	*Cyperus rotundus* L. *Cynodon dactylon* (L.) Pers. *Commelina benghalensis* L. *Ageratum conyzoides* L.
	Dactyloctenium aegyptium (L.) Willd. *Echinochloa colona* (L.) Link, *Digitaria marginata* Stapf, *E. indica.*
	Acanthospermum hispidum DC. *Spilanthes acmella* (L.) Murray, *Eragrostis pilosa* (L.) *P. Beauv. Parthenium*

Crop	Major weeds
	hysterophorus L. *Amaranthus viridis* L. *Alternanthera sessilis* (L.) R. Br. ex DC. *Celosia argentea* L. *Euphorbia*
	hirta L. and *Leucas aspera* (Wild.) Link, *Ocimum canum* Sims
Kodo millet	*Brachiaria reptans, Acrachne racemosa, Dactyloctenium aegyptium, Panicum repens* under grasses, *Cyperus*
	hysterophorus, Digera arvensis and *Tribulus terrestris*
	Cyperus rotundus, Cynodon dactylon, Brachiaria ramosa, Chloris barbata, Dactyloctenium aegyptium,
	Digitaria marginata, Eleusine indica, Echinochloa colona, Ageratum conyzoides, Alternanthera sessilis,
Little millet	*Commelina benghalensis, Cinebra didema, Euphorbia hirta* and *Syndrella nodiflora*
	Echinochloa colona, Enhinochloa crus-gulli, Dactyloctenium aegyptium, Eleusine indica, Setaria glauca,
	Cynodon dactylon, Cyperus rotundus, Celosia argentea, Commelina benghalensis, Phyllanthus niruri, Solanum
	nigrum and *Amaranthus viridis*
	Cynodon dactylon, Phragmites karka, Cyperus rotundus, Sorghum halepanse, Celosia argentea, Commelina
	benghalensis, Phyllanthus niruri, Solanum nigrum and *Amaranthus viridis*
Foxtail millet	
	Sorghum halepense, Amaranthus viridis, Commelina benghalensis, Celosia argentea, Phyllanthus niruri,
	Solanum nigrum and *Cyperus rotundus*

7.2.1 Losses Due to Weeds:

Losses due to weeds in millets can be substantial, significantly impacting agricultural productivity. Weeds compete with millet crops for essential resources such as water, nutrients, and sunlight, leading to reduced yields. The early growth phase of millets, especially during the rainy season when these crops are commonly cultivated, is particularly vulnerable to weed infestations. Weeds, including grasses, sedges, and broad-leaved varieties, can rapidly spread and outcompete millet plants, hampering their growth and development. The competition between millets and weeds intensifies in the absence of effective weed management practices. The yield reduction attributed to weed interference can range from 15% to as high as 97%, causing substantial economic losses for farmers. Additionally, weeds serve as hosts for pests and diseases, further exacerbating the overall crop damage. To mitigate losses due to weeds in millets, implementing integrated weed management strategies becomes crucial. This includes cultural, mechanical, and, where applicable, chemical methods to ensure optimal crop growth and maximize yields.

7.2.2 Crop-Weed Competition:

Crop-weed competition in millets poses a multifaceted challenge to agricultural systems, impacting various aspects of crop development and overall farm management. Weeds not only vie for essential resources but also serve as potential hosts for pests and diseases, compounding the challenges faced by millet crops.

The competition intensifies during the critical phases of millet growth, hindering the establishment and development of crops. Effective weed management strategies are crucial to curtail these losses, with the selection of appropriate methods dependent on factors like the specific weed species present, prevailing soil conditions, and the millet variety being cultivated. Cultural methods, such as intercropping with compatible crops, and mechanical methods, like timely weeding and proper spacing, play pivotal roles in reducing weed interference.

Chemical methods, though used judiciously due to their potential environmental impact, can be integrated as part of a comprehensive approach to weed management. Furthermore, advancements in precision farming technologies provide opportunities to monitor and address crop-weed competition more efficiently. Beyond immediate yield concerns, successful management of crop-weed competition contributes to sustainable farming practices, preserving soil health, and promoting long-term resilience in millet cultivation. As global attention turns towards sustainable agriculture, addressing the complexities of crop-weed competition becomes integral for building resilient and environmentally friendly food production systems.

Table 7.3. Critical Period of Crop-Weed Competition in Millets

Crops	Critical periods (days after sowing)
Sorghum	28–42
Pearl millet	15-30
Finger millet	25–42

7.2.3 Weed Management Methods:

A. Cultural Methods:

Cultural methods of weed management in millets encompass a range of practices rooted in traditional agricultural wisdom and sustainable farming techniques. These methods are aimed at controlling weed growth and promoting the health and productivity of millet crops without relying heavily on chemical interventions. Here are key points highlighting cultural weed management strategies in millet cultivation:

a. **Crop Rotation:** Rotate millet crops with other non-host plants to disrupt weed life cycles and minimize the build-up of specific weed species.

b. **Intercropping:** Planting millets alongside compatible crops can create a natural barrier against weeds and promote a diversified and balanced ecosystem, reducing the likelihood of weed dominance.
c. **Cover Cropping:** Utilize cover crops that suppress weed growth by shading the soil, competing for nutrients, and releasing allelopathic compounds that inhibit weed germination and development.
d. **Mulching:** Apply organic mulches, such as straw or crop residues, to the soil surface to suppress weed emergence, conserve moisture, and enhance soil structure.
e. **Proper Irrigation:** Implement efficient irrigation practices to meet millet water requirements while minimizing excessive moisture that may encourage weed proliferation.
f. **Timely Planting:** Optimal timing of millet planting helps the crop establish quickly and compete more effectively with weeds, reducing the need for weed control measures.
g. **Weed-Free Seed:** Start with weed-free millet seeds to prevent the introduction of weed seeds into the field during the planting process.
h. **Mechanical Weed Control:** Employ manual or mechanical methods, such as hand weeding or the use of appropriate implements, to physically remove weeds from the field without resorting to herbicides.
i. **Adjusting Plant Density:** Optimize millet plant spacing to create a canopy that suppresses weed growth by limiting sunlight penetration to the soil surface.
j. **Community Participation:** Encourage community involvement in weed management practices, fostering a collective approach to address weed challenges and promoting knowledge-sharing among farmers.

These cultural methods collectively contribute to sustainable weed management in millet cultivation, preserving soil health, biodiversity, and the long-term productivity of millet crops.

B. Mechanical Methods:

Mechanical methods of weed management in millets involve the use of various manual and machine-based techniques to control the growth and spread of unwanted plants. These methods are essential for maintaining a healthy millet crop and ensuring optimal yields. Here are key points regarding mechanical weed management in millets:

a. **Hand Weeding:** Manual removal of weeds by hand is a common practice, especially in small-scale farming. It involves uprooting or cutting weeds around millet plants.
b. **Hoeing:** The use of hoes or other hand tools to break up the soil surface and disrupt weed growth. This method is effective in both pre- and post-emergence stages of millet cultivation.
c. **Mechanical Cultivation:** Tractor-mounted implements like cultivators and harrows are used to cultivate the soil, burying weed seeds and destroying emerged weeds. This process is beneficial for weed control in larger millet fields.
d. **Inter-row Cultivation:** Creating a space between millet rows using specialized equipment helps control weeds without disturbing the millet plants. This is particularly useful in preventing weed competition for nutrients and sunlight.

e. **Flame Weeding:** The use of controlled flames to burn weed foliage without causing harm to millet plants. This method is effective in destroying weed seedlings and reducing weed pressure.
f. **Mowing or Cutting:** Regular cutting or mowing of weeds in and around millet fields helps prevent the development and dispersal of weed seeds, promoting a cleaner and healthier crop.
g. **Mulching:** Applying a layer of organic or inorganic mulch around millet plants suppresses weed growth by blocking sunlight and reducing soil moisture availability for weed germination.
h. **Rolling or Crimping:** Using rollers or crimpers to physically crush or damage weed plants, inhibiting their growth. This method is often employed in organic farming systems.
i. **Weed Barrier Fabrics:** Installing physical barriers like geotextiles or weed fabrics around millet plants can prevent weed growth by blocking sunlight and impeding weed access to nutrients.

Adopting a combination of these mechanical methods can significantly contribute to effective weed management in millet cultivation, promoting healthier crops and higher yields.

C. Biological Methods:

Biological control in millets involves the utilization of natural organisms to manage pests and diseases, minimizing the reliance on chemical interventions. This sustainable approach offers several benefits for millet cultivation:

a. **Predatory Insects:** Introducing natural predators such as ladybugs, parasitic wasps, and predatory beetles helps control pest populations by feeding on harmful insects like aphids and caterpillars.
b. **Microbial Agents:** Beneficial microorganisms like bacteria, fungi, and nematodes can be employed to suppress soil-borne pathogens, promoting a healthier soil environment for millet crops.
c. **Trap Crops:** Planting specific crops that attract pests away from millets serves as a natural strategy to divert and control harmful insects, reducing the impact on millet yields.
d. **Crop Rotation:** Alternating millet crops with other plants disrupts the life cycle of pests and diseases, preventing them from establishing persistent populations in the field.
e. **Resistant Varieties:** Developing and cultivating millet varieties with inherent resistance to pests and diseases is a crucial component of biological control, minimizing the need for external interventions.
f. **Conservation of Natural Enemies:** Preserving the habitats and conditions that support natural enemies of pests, such as birds and spiders, contributes to a balanced ecosystem that naturally regulates pest populations.
g. **Integrated Pest Management (IPM):** Combining biological control methods with cultural practices, crop rotation, and judicious use of pesticides, if necessary, forms an integrated approach to pest management in millet cultivation, ensuring sustainability and minimal environmental impact.

7.3 Different Types of Herbicides Use in Millets:

Herbicides play a crucial role in millet cultivation by effectively controlling the growth of unwanted weeds, ensuring optimal crop yields. Various herbicides are employed to manage weed infestations in millet fields. Some notable examples include:

a. **Pre-emergence Herbicides:** Applied before millet seeds germinate, pre-emergence herbicides prevent the growth of weeds. Prominent choices include atrazine and metribuzin.
b. **Post-emergence Herbicides:** These herbicides are applied after millet plants have emerged, targeting actively growing weeds. For millets, options like clethodim and sethoxydim are effective against grassy weeds.
c. **Selective Herbicides:** Designed to target specific types of weeds without harming millet crops, selective herbicides are essential for precision weed control. For instance, fenoxaprop-ethyl is effective against grassy weeds in millets.
d. **Broad-Spectrum Herbicides:** Offering a wide range of weed control, broad-spectrum herbicides like glyphosate are commonly used in millet cultivation. They are effective against a variety of weeds, simplifying weed management practices.
e. **Residual Herbicides:** These herbicides remain active in the soil for an extended period, providing long-lasting weed control. Examples include metolachlor and pendimethalin, which are useful in preventing weed emergence during the early stages of millet growth.

By incorporating a combination of these herbicides into millet farming practices, farmers can ensure effective weed control, promote healthy crop growth, and ultimately enhance overall yield and quality. However, it is crucial to adhere to recommended application rates and guidelines to minimize environmental impact and ensure sustainable agriculture practices.

7.4 Integrated Weed Management:

Integrated Weed Management (IWM) in millets is a comprehensive approach that combines various strategies to effectively control and manage weeds in millet crops. Millets, which include crops like sorghum, pearl millet, finger millet, and foxtail millet, are essential staples in many regions around the world. Weeds pose a significant threat to millet crops, competing for nutrients, water, and sunlight, thereby reducing yields. Integrated Weed Management in millets involves the judicious use of cultural, mechanical, biological, and chemical control methods to minimize the impact of weeds.

Cultural practices such as crop rotation, intercropping, and proper crop spacing can help suppress weed growth. Mechanical methods, such as hand weeding and mulching, contribute to weed control without relying solely on chemical means.

Additionally, incorporating biological control agents, such as beneficial insects, can assist in managing weed populations naturally. By integrating these various approaches, farmers can develop a sustainable and environmentally friendly strategy to enhance millet crop productivity while minimizing the reliance on herbicides and reducing the risk of herbicide resistance.

Table 7.4: Weed Control Measures for Different Millets

Millet	Management of Weeds
Pearl millet	Two hoeing and weeding at 15 and 30 DAS are sufficient for controlling weeds effectively. The herbicidal weed control through pre-emergent application of atrazine @ 0.5 kg a.i./ha followed by with one hand weeding is effective.
Sorghum	Spray atrazine @ 0.5 kg a.i./ha immediately after sowing within 48 h to control weeds. One hand weeding at 20 DAS and inter cultivation two times at 21 and 40 DAS should be done.
Finger millet	The inter-cultivation and weeding should be done with hand hoe at 25 DAS. In line sown crop 2-3 times inter-cultivation and one-time hand weeding is suggested. For Broadcast crop two effective hand weeding will minimize weeds.
Foxtail millet	Two inter cultivations and one hand weeding in line sown crop is recommended for better yields. Two hand weeding in broadcast crop and post-emergence application of 2, 4-D sodium salt (80%) @ 1.0kg a.i./ha at 20-25 DAS should be done.
Barnyard millet	Two inter cultivations and one hand weeding in line sown crop should be done. Two hand weeding should be done in broadcast crop. Post-emergence application of 2, 4-D sodium salt (80%) @ 1.0 kg a.i./ha at 20-25 DAS and Isoproturon @ 1.0 kg a.i./ha as pre-emergence spray is also effective in weed control.
Little millet	Two inter-cultivation and one hand weeding in line sown crop and two hand weeding in broadcast crop are necessary for effective weed control.
Proso millet	Hand weeding may be done for removal of broad-leaf weeds.
Kodo millet	Generally, two weeding at an interval of 15 days are sufficient.
Browntop millet	To control weeds, it is best to plant in a well-tillage field, weed-free bed with narrow row spacing. Chemical weed control options are limited. It does not regrow well after cutting, so it is a single–cut crop.

7.5 Conclusion:

Integrated Weed Management (IWM) is crucial for optimizing millet crop yields sustainably. By combining cultural, mechanical, biological, and chemical control methods, farmers can strike a balance between weed suppression and environmental health.

The adoption of IWM not only mitigates weed-related challenges in millets but also promotes long-term agricultural sustainability.

Collaboration among farmers, researchers, and policymakers is essential to disseminate knowledge and encourage the adoption of these eco-friendly practices, ensuring food security and the resilience of millet farming systems.

7.6 References:

1. Chaudhary, C., Dahiya, S., Rani, S., and Pandey, S. (2018). Review and outlook of weed management in Pearl millet. *IJCS*, *6*(2), 2346-2350.
2. Dubey, R. P., Chethan, C. R., Choudhary, V. K., and Mishra, J. S. (2023). A review on weed management in millets.
3. Girase, P. P., Suryawanshi, R. T., Pawar, P. P., and Wadile, S. C. (2017). Integrated weed management in pearl millet.
4. Jawahar, S., Ramesh, S., Kumar, S. R., Kalaiyarasan, C., Arivukkarasu, K., and Suseendran, K. (2020). Effect of weed management practices on weed indices in transplanted kodo millet. *Plant Arch*, *20*, 3196-8.
5. Mamudu, A. Y., Baiyeri, K. P., and Echezona, B. C. (2019). Integrated weed management systems in sorghum based cropping system in Nigeria.
6. Mashingaidze, N., Madakadze, I. C., and Thomlow, S. (2012). Response of weed flora to conservation agriculture systems and weeding intensity in semi-arid Zimbabwe.
7. Peerzada, A. M., Ali, H. H., and Chauhan, B. S. (2017). Weed management in sorghum [Sorghum bicolor (L.) Moench] using crop competition: A review. *Crop Protection*, *95*, 74-80.
8. Reddy, S. S., Stahlman, P. W., Geier, P. W., Charvat, L. D., Wilson, R. G., and Moechnig, M. J. (2014). Tolerance of foxtail, proso and pearl millets to saflufenacil. *Crop Protection*, *57*, 57-62.
9. Stahlman, P. W., Wicks, G. A., Smith, C. W., and Frederiksen, R. A. (2000). Weeds and their control in grain sorghum. *Sorghum: Origin, History, Technology, and Production. New York, NY: Wiley*, 535-590.