LR-5306
[1-9]

REVIEW ARTICLE Legume Research- An International Journal

Weed Management Practices in Cowpea (*Vigna unguiculata* L.): A Review

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10.18805/LR-5306

ABSTRACT

Cowpea is an important pulse crop. Weeds posses a severe problem in cowpea production and, if it is not managed with best management practices, can act as a hibernating agent and reduce yield and quality. An attempt was made to collect published data on weed management practices aimed at maximizing yield of cowpea. This work was done at Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu, India. The literature search was done during July 2023 to January 2024. About 120 review and research papers were screened from various databases, including the TNAU library, Google Scholar, Scopus, Research Gate, ARCC journals and 75 papers were used to write this paper. This review article documents information gathered on importance of cowpea, nutritional profile of cowpea, anti-nutritional factors, health benefits, critical period of weed control, yield reduction percentage, weed flora in cowpea, SSB, mulching, manual weeding, cultural practices, chemical methods and IWM in cowpea was comprehensively presented.

Key words: Benefits, Cowpea, Critical period, Weed flora, Weed management, Yield reduction.

Pulses are a vital part of the human diet, offering three times more protein than cereals. They are rich in sulphur, calories and B-complex vitamins. Additionally, pulses significantly contribute to our country's farm economy. They are essential for sustainable crop production, particularly in rainfed areas. Overall, pulses play a crucial role in both nutrition and agriculture. Cowpea is important for food security and the livelihoods of millions of smallholder farmers who rely on it for economic and nutritional well-being (Bolarinwa, 2022). Cowpea is a significant leguminous crop extensively cultivated in tropical and sub-tropical regions worldwide, including Asia, Africa, Central and South America (Rathore *et al*., 2015). This versatile crop plays a vital role in providing both valuable livestock fodder besides contributing nitrogen to the soil (Aikins and Afuakwa, 2008).

Particularly appealing for its dual purpose in nature, cowpea is well-suited for cultivation in arid and semi-arid environments across the globe. Due to their high protein content, pulses are an important dietary component in Asian food. In countries like India, where a large percentage of the population is vegetarian, the significance of pulses is much greater. Additionally, they utilize atmospheric nitrogen through biological nitrogen fixation, which is effective and environmentally friendly, thus playing an important role in agriculture. Nevertheless, the productivity of cowpea is low and is due to inadequate weed management. Weed interference is a critical factor affecting cowpea yield, as it competes for water, light and resources, ultimately leading to reduced crop quality and increased production costs. This challenge is exacerbated by the lack of commercially available formulations tailored specifically for cowpea cultivation (Mancuso *et al*., 2016).

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How to cite this article: Manibharathi, S., Swaminathan, C., Somasundaram, S., Kathirvelan, P. and Kannan, P. (2024). Weed Management Practices in Cowpea (*Vigna unguiculata* L.): A Review. Legume Research. 1-9. doi: 10.18805/LR-5306.

Submitted: 16-02-2024 **Accepted:** 21-09-2024 **Online**: 09-12-2024

Timely weeding is crucial to minimize yield losses, with chemical control being an effective alternative. Manual weed removal is the most effective method, but it is time consuming, costly and not widely adopted (Freitas *et al*., 2009). Pre and post emergence herbicides, such as pendimethalin and imazethapyr, have proven effective in controlling various weeds in cowpea (Dixit and Varshney, 2007). Conversely, frequent herbicide applications can increase cultivation costs and complicate the process. Weed infestation in cowpea cultivation can cause yield reductions, up to 76%, depending on the cowpea cultivar, soil and environmental conditions and weed management strategies (Osipitan, 2017).

Coexistence of cowpea with weeds can lead to productivity losses of up to 90%, emphasizing the importance of understanding the critical weed control period, especially in semiarid regions (De Campos *et al*., 2023). Moreover, factors such as competition and allelopathy negatively impact yield traits such as pod number, seed production per pod and grain weight besides increasing cultivation costs (Obadoni *et al*., 2009). In traditional agricultural regions, weed control often resorts to manual hoeing, which proves to be extremely effective against early-stage weeds (Ferreira *et al*., 2014). Yet, the scarcity of labour for agricultural management and economic challenges associated with manual weeding underscore the necessity for exploring and implementing alternative weed management approaches in cowpea.

This review work was done at Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, India. The process spanned nearly seven months, from July 2023 to January 2024, with a dedicated month for manuscript writing. A comprehensive literature search involved the screening and short listing of approximately 120 scientific papers, out of which 75 were utilized in the preparation of this manuscript. Various databases, including the TNAU library, Google Scholar, Scopus, Research Gate, ARCC journals and the TNAU e-library, were employed for the retrieval of review papers.

Importance and nutritional profile of cowpea

Legumes are rich in nutrients and an excellent source of protein, especially in areas where cereal-based diets dominate and child malnutrition is a major issue (Singh *et al*., 2022). Cowpea is a warm-season legume that supplies many individuals with calories and protein, especially in developing countries where poverty and malnutrition are prevalent. Its improved performance in difficult and demanding conditions, its tolerance to heavy rain, nature suffocation (due to its rapid and dense foliage growth) and its soil-restoring properties enable year-round production of pods, grains and forage as a sole crop, cover/trap crop and green manure. Cowpea provides a remedy to the decreasing protein consumption, which is due to the limited availability and high costs of animal protein sources such as milk, eggs, meat and fish (Nordhagen *et al*., 2023). Cowpea grain contains 24.8% protein, 63.6% carbohydrate, 1.9% fat, 6.3% fiber, 7.4 ppm thiamine, 4.2 ppm riboflavin and 281 ppm niacin. With lysine and tryptophan content that is 2-3 times that of cereal, protein is a great addition to grains like rice and wheat. According to Liyanage *et al*. (2014), cowpea contains a significant amount of soluble and insoluble dietary fibre, minerals, vitamins and phytochemicals. Essential amino acids such as lysine, leucine and phenylalanine are also found in cowpea.

Anti-nutritional factors in cowpea

The seeds and leaves contain anti-nutritional substances that can be harmful to humans and animals. These are essentially chemical molecules that sedentary organisms (such as plants, bacteria and fungi) convert into secondary metabolites. Regular ingestion of these metabolites can lead to a build-up of toxins that, in high doses, can cause adverse health effects. Several processing techniques are used to reduce or eliminate anti-nutritional components from cowpea seeds and leaves. These include heat treatment techniques including autoclaving, boiling, microwaving and oven heating, to name a few examples (Shetty and Managanvi, 2013).

Health benefits of cowpea

The Central Council of Ayurvedic and Siddha Research point out that cowpea is a healthy source of protein and soluble fiber that helps keep blood levels of harmful cholesterol under control. They keep blood sugar levels stable and prevent diabetes. Due to cowpea's flavonoid content, consuming it in the diet reduces the risk of heart disease. Cowpea contains antioxidants (gentisic acid, p-coumaric acid, ferulic acid and quercetin) that may be utilised to inhibit the development of malignant cells (Tzanova *et al*., 2023). Additionally, according to a study by Moloto *et al.,* (2020), a 90 g portion of cowpea leaves can fulfill more than 75% of the recommended dietary allowances (RDAs) for vitamin A and 25-50% of the RDAs for iron in children aged 4-8 years.

Critical period of weed competition in cowpea

Weed infestations during early growth stages of cowpea have a negative impact. Therefore, effective weed control during a key period of weed competition optimises cowpea development and yield (Ayisha *et al.,* 2023). In general, weed infestation is an extremely serious problem during the initial growth period (5-8 weeks) in cowpea. And if we take into account the critical period of weed control (CPWC), the minimum period of plant growth during which plants must be kept weed-free to prevent yield loss due to weed competition, for cowpea it is 16 to 38 days after sowing.

A review of the literature (Table 1) clearly shows that a minimum of 10 to a maximum of 57 days is considered a critical period for weed control and the crop should be kept weed-free to minimise the competition. Such a large variation is due to different growing conditions, weed flora and weed density. Statistical analysis revealed that the median value for critical period for CWC under skewed distributions is 26.5 to 37.5 days and the mode value for critical weed competition starts at 20 days and lasts up to 40 days in early growth stages. From the analysis, it could be inferred that keeping cowpea fields weed-free between 26 and 38 days would ensure higher productivity.

Yield reduction (%) in cowpea due to weeds

The influence of weed menace on yield loss has been very well documented by several workers as listed in Table (2), Fig (1). Yield loss in cowpea due to weeds varies from 12.7% to 60.0% depending on the area, soil type, cultivars and agronomic management. About 60% yield loss occurred in Oxisol in Brazil (15°48′13″S, 43°19′3″W and altitude of 510 m) fall under tropical climate with rainy summer and dry winter according to the Köppen-Geiger classification (Santos *et al*., 2018). About 12.7% yield loss occurred in freely drained loamy sand with a pH of between 6.8 and 7.11 located at 7°15′N, 3°25′E of South Western Nigeria during the early (April-July) and late (August-October) cropping season of 2009. The location is characterised by a bimodal rainfall pattern with peaks usually in July and September and short dry spell in August with annual mean of about 1300 mm and a mean temperature of about 27°C (Adigun *et al*., 2014).

The median for the minimum yield reduction is 5%, for the maximum yield reduction it is 76%. It shows that if we fail to keep the cowpea field free from weeds, the yield loss would certainly be great and sometimes even the entire crop could be lost. Therefore, removing weeds in early stages of growth and protecting cowpea from weed competition is a must.

Weed flora in cowpea

Weed flora in cowpea varies with the region, soil and climatic conditions. Major weed flora associated with cowpea was *Cyperus rotundus, Echinochloa* sp., *Cyanodon dactylon, Phyllanthus* sp., *Commelina* sp., *Digera arvensis, Digitaria* sp., *Sorghum halepense* and *Trianthema* sp. as mentioned in Table 3. The two dominant weed species are *Cyperus rotundus* and *Echinochloa* sp.

Stale seed bed (SSB) for weed control in cowpea

Pre-sowing irrigation gave weed seeds an opportunity to germinate and once they emerged, they were eliminated using non-selective herbicides or pre-sowing tillage techniques (Gnanavel and Kathiresan, 2014). The effectiveness of the stale seedbed (SSB) in suppressing weeds is influenced by the preparation process, the weed

Table 1: Critical period of weed control in cowpea.

Critical period of crop-weed competition in cowpea (DAS)	References
0-30	Jawahar *et al*., 2012
11-35	Freitas *et al*., 2009
21-28	Akobundu (2005)
21-28	Sunday and Udensi (2013)
20-30	Gupta *et al*., 2016
14-40	Osipitan *et al*., 2016
15-45	Yaduraju and Mishra (2004)
25-57	Yadav *et al.,* 2018

Table 2: Yield reduction ranges in cowpea crops due to weeds.

Yield reduction (%)	References
25-76	Adigun *et al*., 2014
25-76	Gupta *et al*., 2016
40-80	Sunday and Udensi, 2013
10-35	Das, 2008
15-30	Yaduraju and Mishra, 2004
53-60	Madukwe *et al*., 2012
59.0	Sinchana, 2020
70.8	Mekonnen *et al*., 2015
76.0	Osipitan, 2017
82.0	Tripathi and Singh, 2001
82.0	Muhammad *et al.,* 2003
90.0	Freitas *et al*., 2009
90.0	De Campos *et al*., 2023
45-60	Rouse *et al.,* 2018

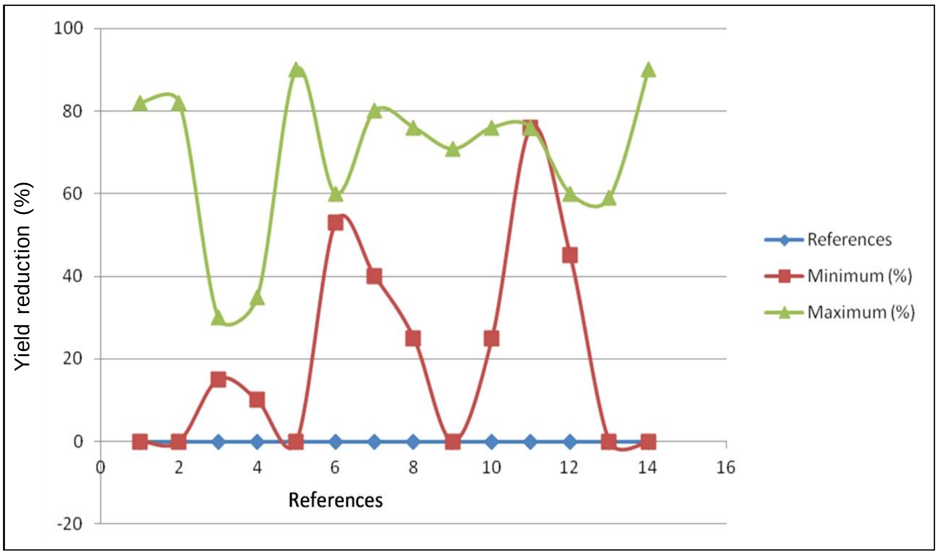

Fig 1: Yield reduction observed in cowpea due to weed competition over years.

Table 3: Major weed species occurred in cowpea field.

Broad leaved weeds

Broad leaved weeds thrive in variety of soil types, from fertile, well-drained soils to compact or disturbed soils. They are found globally, with their species adapt to temperate, tropical, arid and semi-arid regions. Climatic conditions that affect their growth include temperature, precipitation and sunlight, with many species thriving in full sun while others are shade tolerant. Adaptations such as efficient seed dispersal and herbicide resistance contribute to the proliferation of these weeds.

Examples	Family	Authority
Ageratum conyzoides L.	Asteraceae	(Ayisha *et al*., 2023)
Alternanthera sessilis (L.) DC	Amaranthaceae	(Sinchana, 2020)
Brachiaria spp.	Poaceae	(Kumar and Singh, 2017)
Cleome burmannii Wight and Arn.	Cleomaceae	(Ayisha *et al*., 2023)
Commelina sp.	Commelinaceae	(Kumar and Singh, 2017) (Yadav *et al*., 2018)
Leucas aspera (Wild.) Link.	Lamiaceae	Kumar and Singh (2017)
Euphorbia hirta L.	Euphorbiaceae	(Ayisha *et al*., 2023)
Mimosa pudica L.	Fabaceae	
Mitracarpus hirtus (L.) DC.	Rubiaceae	
Mollugo sp.	Molluginaceae	
Phyllanthus sp.	Phyllanthaceae	(Ayisha *et al*., 2023) Kumar and Singh (2017) Sinchana (2020)
Portulaca oleracea L.	Portulacaceae	Kumar and Singh (2017)
Scoparia dulcis L.	Plantaginaceae	(Ayisha *et al*., 2023)
Spermacoce latifolia Aubl.	Rubiaceae	Sinchana (2020)
Synedrella nodiflora (L.) Gaertn	Asteraceae	
Trianthema sp.	Aizoaceae	(Yadav *et al*., 2018)
Tridax procumbens L.	Asteraceae	Kumar and Singh (2017)

Sedges

Sedges typically grow in moist, well-drained to poorly drained soils and are commonly found in wetlands, swamps and along water bodies. They are distributed worldwide and thrive in both temperate and tropical regions. Sedges prefer regions with ample water availability and tolerate a range of climatic conditions from cool to warm temperatures. They generally require high moisture levels and are often found in full sun to partially shaded areas.

Examples	Family	Authority
Cyperus irria L.	Cyperaceae	(Ayisha *et al*., 2023)
Cyperus rotundus L.	Cyperaceae	(Sinchana, 2020) (Yadav *et al*., 2018) (Ayisha *et al*., 2023)

Grasses

Grasses thrive in a wide variety of soils, from fertile, well-drained soils to less fertile, compacted soils. They are found worldwide and inhabit regions ranging from temperate to tropical and even arid. Grasses adapt to various climatic conditions, from cool temperate climates to hot, dry environments. They generally prefer full sunlight, although some species can tolerate partial shade. Moisture requirements vary, with some grasses thriving in moist conditions, such as wetlands, while others are drought tolerant, such as prairies and savannah. These plants are very adaptable and often dominate in disturbed or cultivated soils.

Examples	Family	Authority
Digera arvensis Forsk.	Amaranthaceae	(Yadav *et al*., 2018)
Digitaria sp.	Poaceae	(Ayisha *et al*., 2023) Sinchana (2020)
Echinochloa sp.	Poaceae	Kumar and Singh (2017) (Yadav *et al*., 2018) (Ayisha *et al*., 2023)
Cynodon dactylon L. (Pers.)	Poaceae	(Kumar and Singh, 2017) (Ayisha *et al*., 2023)
Setaria barbata (Lam.) Kunth.	Poaceae	Sinchana (2020)

species present, the method of destroying the emerging weeds, the environmental conditions and the duration (Singh, 2014). In the top 2 cm of soil, stale seedbed significantly reduced the viability of weed seeds such as *Digitaria sanguinalis, Poa annua* and *Eleusine indica*. According to Riemens *et al*. (2007), SSB with the mechanical way of weed control was as successful as the chemical method in reducing weed density. Sinchana (2020) reported that SSB at 15, 30 and 45 DAS, significantly reduced the total density and dry weight of weeds in cowpea. It was also noted that SSB + mulching with dried banana leaves, then Quizalofop-p-ethyl, had the lowest weed index (1%) and maximum weed control efficiency (9.32, 9.49 and 9.77% at 15, 30 and 45 DAS respectively) and green pod yield.

Mulches for weed control in cowpea

In addition to improving the soil organic content, mulching reduces weed populations during the early stages of crop growth by preventing weed emergence (Pereira *et al*., 2011). By lowering soil temperature, raising soil moisture and decreasing weed density, they play a significant part in improving crop output (Mahmood *et al*., 2015). The materials like straw, perennial weeds, water hyacinth, crop left over's derived from perennial crop residues of banana, sugarcane straw, sugarcane biogases, saw dust, news paper and shredded paper (Silva *et al.,* 2015). According to Maia *et al.* (2018), the density of *Cyperus rotundus, Digitaria horizontalis* and *Galinsoga parviflora* populations were considerably decreased in cowpea plots after mulching. In order to effectively control grasses, sedges and broad leaf weeds in cowpea Sinchana (2020) tried mulching with dried banana leaf and found that mulching was effective at 10 t ha^{-1}.

In a study on cowpea conducted by Dukare *et al*. (2017), it was found that organic mulch led to the highest number of nodules per plant, surpassing black polyethylene mulch. Mekonnen and Dessie (2017) discovered that hand weeding and hoeing at 21 days after emergence, in comparison to herbicides, Metalochlor and Pendimethalin, resulted in a higher number of nodules in cowpea. On the other hand, Sinchana (2020) reported that applying Diclosulam pre-emergence at a rate of 12.5 g ha^{-1} resulted in a greater number of nodules in cowpea when compared to hand weeding and mulching with dried banana leaf at a rate of 12 t ha^{-1}. The black polythene mulch treatment surpassed other weed control methods in reducing weed flora, improving weed control efficiency and enhancing crop growth, development and yield. According to Bhasker *et al*. (2023), using plastic mulch is more effective for weed control than applying herbicides and is also economically advantageous.

Manual weeding for weed control in cowpea

Generally, manual weeding is the most widely adopted by farmers to eliminate weeds in cowpea. Hand weeding is considered beneficial as it not only reduces weed growth but also improves the physical properties of the soil. For example, (Ahlawat *et al*., 2005) described that one hand weeding at 25 days after sowing (DAS) resulted in 90% increase in cowpea yield as compare to weed infested plot in north western Indo-Gangetic Plains of India. Hand pulling should be carried out in time and early in the crop growth.

According to Kujur *et al*. (2015), hand weeding at 20 and 40 DAS produced the most pods per plant and a seed output of 1016.66 kg ha^{-1}. According to Kumar and Singh (2017), hand weeding and cross cultural activities at 20 and 40 DAS produced grain yields that were comparable to the weed-free check. According to Kumar *et al.* (2017), two hands weeding followed by one intercultural operation produced the best yield of cowpea (1581.02 kg ha^{-1}) and enhanced production by 25.2% over the weedy control. The lowest weed dry weight, highest number of nodules per plant and highest yield components were observed in cowpea when two and five weak after emergence were used for weeding (Mekonnen and Dessie, 2017). However, Sinchana (2020) noted that pre-emergence treatment of Diclosulam 12.5 g ha^{-1} followed by hand weeding or Quizalofop-p-ethyl at 25 DAS registered the lowest density and dry weight of weeds in bush-type vegetable cowpea was superior to hand weeding twice at 20 and 40 DAS.

Cultural practices

Crop rotation, fertilization, irrigation, cover cropping, plant selection, planting density, geometry and timing have a significant impact on weed suppression. Improving early plant growth and plant vigour improves competitiveness against weeds. Long-term varieties provide early shade in the canopy, inhibiting weed growth, while closer spacing limits weed germination. Crop rotation and cover cropping are critical to weed control because they disrupt weed growth patterns. According to Yadav *et al*. (2017), crop rotation is highly effective against parasitic weeds such as *Striga asiatica, Orobanche* and *Cuscuta spp*.

Intercropping systems, particularly with fast-growing legumes such as greengram and blackgram, increase crop yields and suppress weeds more effectively than sole crops. Key factors affecting weed control include crop species, density, seeding geometry, duration, growth rhythm, soil moisture, fertility and tillage. Intercropping increases the plant canopy and thereby reduces weed growth. Cultural practices such as narrow row spacing and planting of early maturing varieties are also used for weed control in cowpea (Osipitan *et al*., 2018). The lowest number of weeds and weed dry weight and the second highest WCE (99.1%) were recorded with polyethylene mulch followed by quizalofop-ethyl @ 0.05 kg ha^{-1} + 1 hand weeding, whereas no weeds were recorded in the weed-free plot expressed 100% WCE (Dinesh *et al*., 2015).

Adigun *et al*. (2020) demonstrated that using narrow inter-row spacing (60 cm) along with two hoe weeding at 3 and 6 weeks after sowing enhances weed control and increases cowpea productivity. The combination of the SAMPEA 12 variety with ploughing and harrowing resulted in the highest seed yield (667.00 kg ha^{-1}) and is recommended for adoption due to its exceptional yield and effective weed control in cowpea production (Nwagwu *et al*., 2022).

Chemical method

Chemical weed control using suitable herbicides at lower dosages can be an effective approach for managing weeds in cowpea and increasing profits. Hanumanthappa (2012) reported that applying pre emergence herbicide Pendimethalin at 0.75 kg ha^{-1}, followed by hand hoeing at 20-25 DAS, provided broad spectrum weed control and higher cowpea yields. Oluwafemi *et al.* (2016) found that applying Pendimethalin three days before planting effectively controlled weeds and resulted in the highest cowpea grain yield. Sinchana (2020) found that using pre-emergence herbicide Diclosulam at 125 g ha^{-1}, followed by post-emergence Quizalofop-p-ethyl or manual weeding, effectively minimized weed density and dry weight in bush-type vegetable cowpea. The use of Pendimethalin at 750 g ha^{-1} followed by Imazethapyr at 60 g ha^{-1} 30 days after sowing has been shown to be an equally effective and profitable weed management strategy for cowpea (Parmar *et al*., 2022).

Gupta *et al.* (2016) observed that the combination of Imazethapyr and Imazemox at 40 g ha^{-1} produced maximum seed yield and weed control efficiency. Yadav *et al.* (2016) stated that Imazethapyr at 75 g ha^{-1}, followed by hand weeding at 40 DAS, was the most effective for weed control in fodder cowpea. Teli *et al*. (2020) found that the lowest dry matter of weeds, highest weed control efficiency and superior growth parameters, yield attributes and yield were achieved with the pre-emergence application of pendimethalin at 750 g ha^{-1} combined with post-emergence imazethapyr + imazamox at 33.75 g ha^{-1} applied 15-20 days after sowing. Kumar and Singh (2017) reported reduced weed dry weight with Imazethapyr at 75 g ha^{-1} or Quizalofop-p-ethyl at 40 g ha^{-1} at 20-25 DAS, followed by hand weeding and intercultural operation at 40-45 DAS. Sinchana (2020) indicated that mulching with dried banana leaf at 10 t ha^{-1}, followed by Imazethapyr at 50 g ha^{-1} on the 25th day, significantly reduced the density of sedges, broad leaf weeds and grasses in cowpea.

Maurya *et al*. (2023) demonstrated that pre-emergence application of Pendimethalin at 6 ml l^{-1} followed by one hand weeding, as well as pre-emergence application of Pendimethalin at 6 ml l^{-1} combined with Quizalofop ethyl at 40-50 g ha^{-1} at 25 DAS, significantly reduced weed numbers (48.12 and 52.18 m^{-2}). These treatments also resulted in the highest plant height (47.30 and 45.98 cm), pod length (21.64 and 20.86 cm), number of pods plant^{-1} (35.94 and 34.18), average pod weight (11.18 and 11.06 g), green pod weight plant^{-1} (367.84 and 348.63 g), green pod weight plot^{-1} (11.24 and 10.54 kg) and green pod yield (118.96 and 111.55 q ha^{-1}). These weed management practices could serve as alternatives to manual weeding and are recommended for farmers seeking higher returns from cowpea. According to Bhasker *et al.* (2023), the pre-emergence application of oxyfluorfen at 150 g ha^{-1} combined with one hand weeding at 35-45 DAS achieved the highest weed control efficiency, pod yield and benefit-cost ratio (1:2.07), followed closely by the pre-emergence application of pendimethalin at 1.0 kg ha^{-1} (1:2.06).

Integrated weed management (IWM)

Integrated weed management (IWM) is used to maintain the weed population below the economic threshold (ETL). Essentially, integrated weed management combines economically viable weed control strategies that farmers could adopt, such as mechanical, chemical, biological and cultural methods (Pooniya *et al.,* 2014). Integration of chemical weed control along with manual weeding such as pre emergence application of Pendimethalin @ 2.01 *a.i.* ha^{-1} followed by one hand weeding at 30 days after sowing resulted in lower weed population and weed dry matter, which improved the cowpea yield during rainy season (Patel *et al*., 2003). Similarly, (Jaibir *et al*., 2004) reported that Pendimethalin 1.0 kg ha^{-1} as pre-emergence application along with one hand weeding at 30 days after of sowing provided effective weed control in cowpea field. Likewise, (Madukwe *et al*., 2012) reported that chemical weeding at 2-3 leaf stage of weed growth followed by hand weeding at 50 DAS proved effective in controlling weeds in cowpea field and also produced the highest cowpea seed yield.

Controlling weeds using 1.0 kg ha^{-1} of s-metolachlor combined with hand weeding and hoeing at 35 days after emergence (DAE) was the most economically advantageous method. However, when labour is limited and herbicide availability is timely, applying 2.0 kg ha^{-1} of s-metolachlor pre-emergence is recommended to prevent yield losses and maximize benefits (Mekonnen *et al.,* 2015). Integrated weed management represents a superior choice, allowing cowpea farmers to substitute cultural practices such as one hand weeding and one intercropping at 20-25 days after sowing (DAS) with appropriate herbicide applications to achieve increased yields (Kumar and Singh, 2017). Applying sorghum residue at 10 t ha^{-1} to plots treated with half the recommended rate of trifluralin herbicide resulted in a significantly higher seed yield compared to using the full label rate of the herbicide alone. This method offers a viable and environmentally friendly weed management strategy for cowpea (Alsaadawi *et al*., 2019). Pendimethalin 0.75 kg ha^{-1} + mulching 7.0 t ha^{-1} which is indicated that pre-emergence herbicide application could be effectively manage the weeds at early season and later emerged weeds could be successfully controlled by mulching (Amaya *et al*., 2022).

CONCLUSION

To maximize yield and ensure cowpea plant health, weed control is essential. Cowpea yield loss can vary significantly, ranging from 25% to up to 76%. This variation is influenced by factors such as weed species, weed density, soil, climate and effectiveness of weed control practices. To minimize these losses and ensure optimal cowpea production, proper weed control is essential. Although traditional weed control methods are tried and tested, they often have shortcomings in terms of efficiency and effectiveness. Manual weed control provides precise control but can be labor intensive. Chemical weed control offers high efficiency but can cause environmental problems. The combination of both methods improves weed control and improves crop yields and sustainability in cowpea. This integrated approach provides a balanced solution that leverages the strengths of both manual and chemical strategies. Application of some predominant herbicides such as pendimethalin, quizalofop-p-ethyl and imazethapyr play an important role in chemical weed control in cowpea. Integrated weed management is an ideal weed control method in cowpea. By adapting these strategies to specific local conditions, farmers can achieve higher yields and sustainable weed management in cowpea.

ACKNOWLEDGEMENT

We would acknowledgement the support provided by TNAU library for literature access.

Statements and declarations

Funding support

There is no funding (institutional, private and/or corporate financial support) received for the work reported in their manuscript.

Conflict of interest

All authors declared that there is no conflict of interest.

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