Effect of various Weed Management Practices on various parameters of Chickpea Crop: A Comprehensive Review

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Abstract— *This review synthesizes recent advancements in weed management for chickpea cultivation, emphasizing both mechanical and chemical approaches. Mechanical strategies, such as hand weeding at 30 and 60 days after sowing (DAS), significantly improve yield and seed protein content by effectively reducing weed competition. Strategic hoeing also enhances crop growth but requires careful timing to prevent increased weed density. Chemical control methods, including pendimethalin and imazethapyr, show effective weed suppression when applied correctly, though excessive use can lead to reduced yields. Combining pendimethalin with manual weeding provides optimal results, balancing robust weed control with plant health. This review highlights the importance of integrating mechanical and chemical strategies to achieve sustainable chickpea production. Future research should focus on optimizing these integrated approaches, developing eco-friendly herbicides, and adapting management strategies to varying climatic conditions to further enhance chickpea yield and quality.*

Keywords— Chickpea, hand weeding, imazethapyr, pendimethalin, growth attributes.

I. INTRODUCTION

Weeds are a significant constraint in chickpea production, competing with the crop for essential resources such as nutrients, water, light, and space, leading to substantial yield reductions. Traditional mechanical methods like hand weeding and hoeing have long been the primary means of weed control, but they are labor-intensive and time-consuming. Chemical herbicides offer an alternative approach, providing more efficient weed management, though their use raises concerns about environmental impact, resistance development, and residual effects on soil health and crop safety.

This review synthesizes findings from various studies to offer a comprehensive understanding of the effects of both mechanical and chemical weed management practices on chickpea production. It evaluates the trade-offs between these methods, considering factors such as labor requirements, cost-effectiveness, environmental sustainability, and overall impact on crop yield. The aim is to guide the development of integrated weed management strategies that maximize productivity while minimizing adverse effects.

II. REVIEWS OF LITERATURE

2.1 Effect of Mechanical Weed Management Practices:

2.1.1 Effect on Weed Flora in Chickpea:

[1] Identified dominant weed flora in chickpea fields at Guntur, Andhra Pradesh, including grasses (*Echinochloa spp*., *Panicum spp*.), sedges (*Cyperus rotundus*), and broadleaf weeds (*Chrozophora rottleri*, *Phyllanthus niruri*).

[2] Recorded the predominant weed species in experimental field were *Cynodon dactylon* L., *Cenchrus biflorus* L., *Dactylocatenium aegyptium*, *Boerhavia diffusa* L. *Corchorus olitorius* L., *Portulaca oleracea* L., *Tribulus terrestris* L., *Spergula arvensis* L. and *Cyperus rotundus* L. in green gram.

[3] Identified the dominant weed flora. Monocots included *Cyperus rotundus*, *Elurops vellosus*, *Eleusine indica*, *Dactyloctenium aegyptium*, and *Asphodelus tenuifolius*. Dicots comprised *Chenopodium album*, *Chenopodium murale*, *Melilotus indica*, *Boerhavia diffusa*, *Portulaca oleracea*, *Euphorbia hirta*, and *Digera arvensis*.

[4] Reported that the field experiment at Haryana and registered *Chenopodium album*, *Medicago denticulata* and *Phalaris minor* as the most dominant weeds in chickpea, and constituted 44.6 %, 29.9 % and 15.3 % of the total weed population, respectively.

[5] Observed that the weed flora in the experimental field of chickpea were *Medicago denticulate*, *Convolvulus arvensis*, *Chenopoium album*, *Melilotus indica*, *Bracharia mutica*, etc. at IGKV, Raipur, Chattisgarh.

[6] Reported that *Melilotus alba, Chenopodium album, Cynodon dactylon, Phalaris minor* and *Medicago hispida* were the major weeds in rabi season in the experimental field trail.

A field experiment in Tikamgarh, Madhya Pradesh, revealed monocot weeds dominated with a relative density of 68.2%, compared to 24.2% for dicots. *Cyperus rotundus* and *Cynodon dactylon* were the most prevalent monocots, while *Launea pinnatifolia* led among dicots **[7].**

[8] Examined during experiment that among monocots *Brachiria mutica, Echinochloa crusgalli* L. and *Cynodon dactylon* L.; *Cyperus rotundus* among sedges and *Amaranthus viridis* L.*, Digera arvensis, Physalis minima, Euphorbia hirta, Parthenium hysterophorus* and *Alternanthera sessilis* among dicots were the prominent weeds at Parbhani, Maharashtra.

[9] Observed that the infestation of *Chenopodium murale, Chenopodium album* and *Rumex Dentatus* and among these *Chenopodium murale* was the most dominant weed species during the research trail.

[10] Reported that *Solanum nigrum, Medicago polymorpha, Galinsoga parviflora, Commelina benghalensis, Parthenium hysterophorus* and *Cyperus rotundus* were the prominent weeds infesting the chickpea at Haramaya, Ethiopia.

[11] Reported that in weedy check plots, the primary weeds included *Cynodon dactylon*, *Cyperus rotundus*, *Chenopodium album*, *Anagallis arvensis*, *Convolvulus arvensis*, *Medicago hispida*, *Argemone mexicana*, and *Parthenium hysterophorus*. *Cynodon dactylon* was the main monocot weed at 7.33/m², while *Chenopodium album* dominated dicots at 134.33/m², with respective relative densities of 4.05% and 74.36% at 30 DAS.

[12] Concluded that PPI and PRE application of pendimethalin + imazethapyr (RM) @ 1000 g a.i. ha^{-1} gave excellent control of complex weed flora and increased the yield of chickpea significantly over the weedy check.

2.1.2 Effect of Hand Weeding on Chickpea:

[13] Observed that Hand weeding twice, at 30 and 60 DAS, resulted in the highest net returns in the chickpea + linseed intercropping system. The benefit-to-cost (B:C) ratio was 1.29 in the first year and 0.96 in the second year, demonstrating the economic effectiveness of this weed management strategy.

[14] Reported that the weed-free plot showed the highest number of nodules and branches per plant, along with the greatest fresh and dry weights. This was followed closely by the plots where hand weeding was performed, highlighting the significant benefits of maintaining weed-free conditions for optimal plant growth and productivity.

[15] Concluded that the significant maximum number of pods $plant^{-1}$, number of branches $plant^{-1}$ and dry matter $plant^{-1}$ and found maximum seed yield $plant^{-1}$, lower weed density and dry matter with hand weeding at 25 DAS.

[16] Revealed that chickpea plants reached their maximum height and produced the most pods per plant when hand weeding was used as the treatment. Conversely, the lowest plant height and pod production were recorded in the weedy check plots, highlighting the importance of hand weeding for optimal chickpea growth and productivity.

[4] Reported that weed-free treatments resulted in the highest number of branches and pods per plant, along with the greatest 100-seed weight and seed yield. These results were comparable to those achieved with two rounds of hand weeding, indicating the effectiveness of both methods for enhancing plant productivity.

[17] Found that weed-free treatments, with hand weeding at 20, 40, and 60 DAS, resulted in the lowest weed population and dry weight of weeds. This approach also led to higher stover and seed yields, demonstrating the effectiveness of consistent weed management throughout the growing season.

[18] Reported that performing two manual weedings at 30 DAS significantly increased the number of pods per plant and seed yield in chickpea. This indicates that timely and repeated manual weeding can enhance chickpea productivity by improving pod and seed development.

2.1.3 Effect of Hoeing on Chickpea:

[6] Concluded that hoeing at 20 and 40 days after sowing (DAS) led to increased weed density and dry weight but improved crop growth in Dharwad. This suggests that timely hoeing significantly influences both weed management and crop development under the specific conditions of Dharwad.

[7] Reported that applying Pendimethalin along with hand hoeing led to increased numbers of pods per plant, seeds per plant, seed weight per pod, test weight, and seed yield compared to the weedy check. This combined approach effectively enhances various growth parameters and overall seed production in chickpeas.

[19] Revealed that the weed density, dry weight, and control efficiency were better with the treatment compared to hand weeding. Additionally, this treatment positively affected the number of pods per plant, seeds per pod, and seed yield, outperforming the weedy check, thereby demonstrating its effectiveness in enhancing chickpea productivity.

[20] Revealed that three times hoeing gave number of seed per plant, yield per plant, harvest index and biological yield at par than two times hoeing, one time hoeing no weed control treatment. It showed that hoeing is an important factor as well as economic treatment.

[21] Showed that weed free and two hand hoeing reduced the weed population drastically which was statistically at par with PRE application of pendimethalin + imazethapyr (RM) at 1000 g a.i. ha^{-1}. *Chenopodium album, Fumaria parviflora and Anagallis arvensis* were effectively controlled by RM irrespective of its time of application.

2.2 Chemical Weed Management Practices:

2.2.1 Growth and Weed Attributes:

[22] Found Quizalofop at 50 g ha^{-1} at 30 days after sowing (DAS) achieved 38.4% weed control efficiency in chickpea. However, this treatment also led to a 26.0% reduction in yield. This indicates that while Quizalofop effectively controls weeds, it may negatively impact chickpea yield.

[23] Found that weed free treatment resulted in significant increase in number of pods $plant^{-1}$, weight of pods $plant^{-1}$, seeds pod^{-1}, 100 grain weight overall the treatments. They also reported that Pendimethalin @ 0.75 kg ha^{-1} pre-emergence was significantly superior to rest of chemicals.

[3] Showed that Pendimethalin at 1.0 kg ha^{-1} applied as pre-emergence, combined with one hoeing at 30-35 DAS, resulted in significantly higher numbers of branches and pods per plant, and seed yield. This treatment was comparable to Pendimethalin at 1.0 kg ha^{-1} with one weeding at 25-30 DAS, and Oxyfluorfen at 0.25 kg ha^{-1} with one hoeing at 30-35 DAS.

[16] Observed that post-emergence application of Imazethapyr resulted in the lowest weed population in chickpea. This efficacy is attributed to its superior weed control performance compared to other herbicides. The effective management of weeds with Imazethapyr highlights its potential as a key component in enhancing chickpea crop yield and maintaining optimal growing conditions.

[24] Reported that Pendimethalin at 1.0 kg ha^{-1} PRE effectively reduced monocot, dicot, and sedge weed populations at 25, 50 DAS, and harvest. This treatment led to the lowest weed dry weight, highest weed control efficiency and a reduced weed index.

[25] Found that applying Imazethapyr at 50 g ha^{-1} followed by one hand weeding was effective in reducing the population of dicot weeds. At 25 DAS, weed density was 3.92 m^{-2}, and at 50 DAS, it was 4.15 m^{-2}. The dry weight of weeds was also lower with this treatment, measuring 6.28 m^{-2} at 25 DAS and 8.27 m^{-2} at harvest, outperforming other weed management practices.

[26] Found the application of Imazethapyr at 30 g ha^{-1} at 10 DAS resulted in a 57.9% increase in seed yield, reduced weed dry matter and a higher weed control efficiency (75.33%) compared to the weedy check and other treatments. This treatment also achieved the highest net returns and a benefit-to-cost ratio of 2.08, closely followed by Imazethapyr at 20 g ha^{-1} applied at 10 and 20 DAS, and Imazethapyr at 30 g ha^{-1} at 30 DAS.

[11] Reported that higher weed control efficiency at 30 DAS was recorded with fomesafen 220 g + fluazifop-p-butyl 220 g ha^{-1} followed by hand weeding at 20 and 40 DAS. Though, fomesafen 220 g + fluazifop-p-butyl 220 g ha^{-1} PoE at 20 DAS and imazethapyr + imazamox 100 g ha^{-1} PoE at 20 DAS caused severe injury to chickpea plants and even mortality of a few plants.

[27] Concluded that among the herbicides tested, Oxyfluorfen achieved the highest plant height, number of leaves, and number of branches at harvest. Its effectiveness in increasing plant height was comparable to Quizalofop-p-ethyl at 100 g a.i. ha^{-1}applied at 25 DAS. This demonstrates Oxyfluorfen's strong performance in enhancing key growth parameters, making it a competitive option for improving plant development.

[28] Found that weed management methods significantly influence the number of nodules, nutrient uptake, yields, and economic returns of chickpea compared to the weedy check. Effective weed control enhances these growth parameters, leading to improved crop performance and profitability. This highlights the critical role of appropriate weed management in optimizing chickpea production.

[21] Showed that the herbicides combined during PPI and PRE stages exhibited excellent control over a diverse weed population, leading to a significant increase in chickpea yield compared to the weedy check. The number of seeds per pod, pods per plant, and branches per plant varied significantly with different weed control treatments.

2.2.2 Effect on Yield and Yield Attributes:

[1] Reported that post-emergence application of Imazethapyr 63 g ha^{-1} caused 20% crop injury among the herbicides under study. Integrated treatments were found to be superior (83-89% WCE) too alone 10 application of herbicides. Among the treatments, pre-emergence application of oxyfluorfen 100 g ha^{-1} fb hand weeding at 30 DAS recorded maximum grain yield of chickpea.

[29] Reported that both Imazethapyr and Quizalofop-ethyl reduced grain yield at higher application rates due to phytotoxic effects. These herbicides, while effective at controlling weeds, can negatively impact crop yield when used excessively, highlighting the importance of adhering to recommended application rates to avoid detrimental effects on plant health and productivity.

[18] Conducted a field experiment during winter season in Parbhani on chickpea revealed that application of Quizalofop-ethyl 40 g ha^{-1} gave significantly superior seed yield over rest of chemical weed control and weedy check.

[7] Found Seed yield was significantly higher with all weed control practices compared to the weedy check. Two hand weedings at 20 and 40 DAS achieved the highest yield, followed by Pendimethalin at 1.0 kg ha^{-1} combined with hand weeding at 30 DAS. Pre-emergence applications of Pendimethalin at 1.0 kg ha^{-1} and Alachlor at 1.0 kg ha^{-1} also resulted in significantly higher seed yields compared to straw mulch and weed mulch.

[30] Reported that the maximum reduction in seed and straw yield was observed with the pre-emergence application of pendimethalin at 750 g ha^{-1} followed by a combined post-emergence application of quizalofop-ethyl at 60 g and oxyfluorfen at 200 g ha^{-1} at 35 DAS. This was on par with the post-emergence application of oxyfluorfen with quizalofop-ethyl or clodinafop. The reduction might be due to inadequate weed control and the phytotoxic effects of herbicides on crops.

[31] Concluded that the application of pendimethalin 30 ec @750 g ha^{-1} as pre-emergence (PE) recorded mean maximum seed yield trailed by application of metalachlor 50 ec @1000 g ha^{-1} and were significantly superior over remaining treatments.

[27] Reported that the highest seed yield was recorded by the weed-free treatment, which was comparable to hand weeding at 30 DAS and hoeing at 45 DAS, oxyfluorfen (23.5% EC) @ 0.17 Kg a.i. ha^{-1}, and quizalofop-p-ethyl 100 g a.i. ha^{-1} at 25 DAS. The herbicide oxyfluorfen (23.5% EC) @ 0.17 Kg a.i. ha^{-1} (PE) yielded the highest seed production, which was comparable to quizalofop-p-ethyl 100 g a.i. ha^{-1} at 25 DAS.

[28] Concluded maximum yield and nutrient uptake by chickpea were recorded in weed free treatment but maximum NPK uptake by weeds were obtained in weedy check treatment and lowest in weed free treatment.

[32] Revealed that Pendimethalin applied at 1 kg a.i. ha^{-1} as a pre-plant incorporation (PPI) increased seed and haulm yield in chickpea by effectively controlling weeds during critical growth periods, thus enhancing resource availability for plants. This was comparable to hand hoeing at 30 DAS. The highest seed yield was achieved with hand weeding at 30 DAS, significantly outperforming other treatments due to the elimination of all weeds during this critical period.

[33] Revealed that the highest number of pods per plant, seeds per pod, seed index, seed yield, and stover yield in chickpea were achieved with the application of Oxyfluorfen at 150 a.i. ha^{-1} as a pre-emergence treatment followed by Topramezone at 20.6 a.i. ha^{-1} as a post-emergence treatment. This combination proved most effective in enhancing various growth and yield parameters in chickpea cultivation.

2.2.3 Effect on Quality of Chickpea:

[17] Concluded that the highest protein content in chickpea seeds was observed in plots kept weed-free until harvest through hand weeding at 20, 40, and 60 days after sowing (DAS). This treatment was significantly more effective than all other combinations, highlighting the importance of maintaining a weed-free environment throughout the crop's growth period to maximize protein content in the seeds. Weed control is crucial for optimal seed quality.

[34] Reported that the protein content in chickpea seeds was comparable when hand weeding was performed at 30 and 60 days after sowing (DAS) compared to other treatments, including pendimethalin applied pre-emergence (PE) and imazethapyr and quizalofop applied post-emergence (POE) at 20 DAS. This suggests that manual weed control at these intervals effectively maintains seed protein levels, offering an alternative to chemical weed management practices.

[35] Concluded that performing hand weeding twice, at 25 and 50 days after sowing (DAS), resulted in the highest protein content in chickpea seeds. This method was more effective compared to treatment combinations involving pendimethalin applied as a pre-emergence (PE) treatment and a combination of pendimethalin with imazethapyr applied post-emergence (POE). Hand weeding provided superior results in maintaining seed protein levels compared to these chemical treatments.

[12] Showed that the application of herbicides as pre-plant incorporation (PPI) and pre-emergence (PRE) did not cause any phytotoxic effects on chickpea plants. These findings indicate that such herbicide applications are safe for chickpea cultivation, as they do not harm the crop during its early growth stages. This provides an effective weed management strategy without compromising the health or yield of the chickpea plants.

III. CONCLUSION

This review underscores the effectiveness of both mechanical and chemical weed management strategies in chickpea cultivation. Mechanical practices, such as hand weeding and hoeing, significantly reduce weed density and enhance crop productivity, with hand weeding at 30 and 60 days after sowing (DAS) notably improving seed yield and protein content. Timely hoeing also benefits crop growth but requires careful management to avoid increasing weed density. Chemical methods, including pendimethalin and imazethapyr, effectively control diverse weed species when applied pre- and post-emergence without causing phytotoxicity, provided recommended rates are followed. Combining chemical and mechanical methods, like pendimethalin with manual weeding, achieves a balance between effective weed control and plant health. Future research should focus on optimizing these integrated strategies, developing low-impact herbicides, and employing precision weed management techniques. Additionally, exploring interactions between weed management practices and climate variations can provide insights for adapting strategies to diverse agroecological conditions, enhancing the sustainability and productivity of chickpea farming globally.

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