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# Weed Dynamics and Productivity of Chickpea as Influenced by Integrated Weed Management Practices

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***Abstract—*** *Chickpea (Cicer arietinum L.) is a major pulse crop of India; however, its productivity is severely affected by early-season weed competition, resulting in yield losses ranging from 40 to 60 percent. Slow canopy development and wider row spacing make the crop more vulnerable to weeds during 20–40 days after sowing, which is considered the critical period of competition. The present review compiles information on weed diversity, chemical weed control efficacy, and integrated strategies in chickpea. The dominant weed complex consists of Chenopodium album, Cyperus rotundus, and Parthenium hysterophorus. Sequential application of pendimethalin as pre-emergence @ 1.0 kg a.i. ha⁻¹ followed by imazethapyr as post-emergence @ 75 g a.i. ha⁻¹ recorded the highest weed control efficiency and lower weed biomass, with grain yield at par with two hand weedings. Combination of herbicide with one manual weeding was found to be economically viable and ecologically sustainable. This paper also highlights future thrust areas including evaluation of new herbicide molecules, soil health assessment and precision-based weed management.*

***Keywords— Chickpea, weed dynamics, pendimethalin, imazethapyr, IWM.***

## I. INTRODUCTION

Chickpea is the premier pulse crop of India, accounting for nearly 45 percent of total pulse output (AICRP, 2022). In Chhattisgarh, it is cultivated mainly under rainfed conditions during the rabi season, but the average productivity (1020 kg ha⁻¹) is much below the potential. Weed infestation is recognized as a key biotic limitation, causing yield reductions of up to 30–57% (Chaudhary et al., 2011). Owing to its initial slow growth habit and wider spacing, the crop faces severe weed pressure at early vegetative stages. The period between 20 and 40 DAS has been identified as crucial for crop–weed competition (Singh et al., 2014). The weed spectrum in chickpea fields includes *Chenopodium album*, *Anagallis arvensis* and *Cyperus rotundus* as predominant species (Kumar et al., 2019). Although manual weeding gives excellent control, scarcity and high wages of labour restrict its large-scale adoption (Rathod et al., 2017). Application of pendimethalin as pre-emergence and imazethapyr as post-emergence has been reported to provide superior weed control with a higher benefit-cost ratio (Yadav et al., 2020; Verma et al., 2021).

## II. CHEMICAL WEED MANAGEMENT

Due to labour shortage at critical stages, herbicidal control has become the most feasible and cost-effective approach (Rathod et al., 2017). As pre-emergence, pendimethalin @ 1.0 kg a.i. ha⁻¹ at 2 DAS effectively minimized weed population and biomass, exhibiting weed control efficiency up to 78.5% (Yadav et al., 2020). In the case of post-emergence, imazethapyr @ 100 g a.i. ha⁻¹ at 20 DAS provided excellent control of both dicot and monocot weeds and resulted in minimum weed index (Verma et al., 2021). Sequential use of pendimethalin fb imazethapyr proved more effective in broad-spectrum weed control and recorded higher grain productivity compared to their sole application (Kumar et al., 2019). Similarly, a tank mix of imazethapyr + imazamox @ 70 g ha⁻¹ showed superiority in terms of profitability (Singh et al., 2014).

## III. WEED FLORA IN CHICKPEA

The weed community in chickpea is location-specific and comprises mainly broad-leaved weeds followed by grasses and sedges. The higher proportion of broadleaf weeds is attributed to the rabi season and wide row arrangement. Kumar et al. (2019) documented *Chenopodium album*, *Anagallis arvensis*, *Melilotus indica* and *Vicia sativa* as major dicot weeds, while *Phalaris minor* and *Avena ludoviciana* as major monocots in North Indian conditions. In Central India, the field was dominated by *Medicago denticulata*, *Cynodon dactylon* and *Cyperus rotundus* (Rathod et al., 2017). Singh et al. (2014) reported that 65–70% of the total weed count was constituted by broadleaf weeds, which compete intensely for moisture, nutrients and light.

## IV. EFFECT ON WEED DYNAMICS

Weed dynamics is assessed through parameters like weed count, weed dry matter, weed control efficiency and weed index. Yadav et al. (2020) observed minimum weed density with two hand weedings at 20 and 40 DAS, which was statistically comparable to sequential application of pendimethalin fb imazethapyr. Verma et al. (2021) recorded a 72% reduction in total weed dry weight with the sequential herbicide program over the weedy check. The maximum weed control efficiency (82.4%) was noted under double hand weeding, followed by the integrated treatment (78.5%) (Rathod et al., 2017). Among herbicidal treatments alone, the ready-mix of pendimethalin + imazethapyr exhibited higher control than solo application (Kumar et al., 2019). The weed-free condition showed the lowest weed index (4.2%), indicating negligible yield loss due to weed interference (Singh et al., 2014).

## V. WEED MANAGEMENT PRACTICES

Weed control in chickpea is achieved through cultural, mechanical, chemical and integrated methods. The cultural approach includes adoption of a higher seed rate, closer spacing (22.5 cm) and timely sowing, which facilitate early ground coverage and suppress weeds (Singh et al., 2014). The mechanical method comprising two hand weedings at 20 and 40 DAS provides excellent control and maximum productivity but becomes uneconomical under labour scarcity (Rathod et al., 2017). Chemical control through sequential application of pendimethalin fb imazethapyr is identified as the most promising herbicidal option. Integrated weed management involving pendimethalin @ 0.75 kg $ha^{-1}$ + one hand weeding at 30 DAS produced weed control comparable to double hand weeding with higher monetary returns (Yadav et al., 2020). IWM is considered the most sustainable strategy for long-term weed management (Kumar et al., 2019).

## VI. EFFECT ON GROWTH AND YIELD ATTRIBUTES

Effective weed management favours better plant height, branches, pods per plant and test weight. The weed-free condition recorded the tallest plants (48.2 cm) and maximum branches (6.8 $plant^{-1}$), at par with the sequential herbicide treatment (Verma et al., 2021). Lower crop–weed competition during early stages enhanced dry matter production (Singh et al., 2014). The highest number of pods (42.5 $plant^{-1}$) and 100-seed weight (18.6 g) were obtained under two hand weedings, followed by pendimethalin + one hand weeding (Rathod et al., 2017). Uncontrolled weed growth reduced grain yield by 42–58%. Sequential herbicide use improved yield by 68% over the weedy check and remained comparable to manual weeding (Yadav et al., 2020; Kumar et al., 2019).

## VII. RESEARCH GAPS AND FUTURE PROSPECTS

Though substantial work has been done on chemical control, certain gaps still exist. The majority of investigations are confined to pendimethalin and imazethapyr, while information on novel molecules and ready-mix formulations to avoid herbicide resistance is limited (Verma et al., 2021). The residual effect of continuous herbicide use on soil microorganisms, nodule formation and subsequent crops in chickpea-based cropping systems is not well documented (Rathod et al., 2017). Location-specific precision weed management models based on the critical period for different agro-climatic regions, particularly for Chhattisgarh, are lacking (Singh et al., 2014). Future lines of work should emphasize IWM modules combining herbicides with mulching and competitive cultivars, screening of broad-spectrum post-emergence herbicides that are safe to *Rhizobium*, and breeding of herbicide-tolerant chickpea genotypes.

## VIII. CONCLUSION

Weeds pose a severe threat to chickpea productivity, causing 40–60% grain yield loss when not managed within 20–40 DAS. Double hand weeding is biologically most effective but not economically viable due to high labour requirement. Sequential application of pendimethalin as pre-emergence followed by imazethapyr as post-emergence and integration of herbicide with

one hand weeding were found to be practically feasible, economically remunerative and highly efficient in controlling weeds and improving growth and yield components. Therefore, adoption of integrated weed management is recommended for sustainable chickpea cultivation.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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