**Effect of new generation herbicides on weed dynamics and yield of chickpea (*Cicer arieti*num L.)**

**ABSTRACT**

The present research was conducted to study the differential doses and time applications of topramezone on weed dynamics and yield of chickpea (*Cicer arietinum* L.) at agronomy research farm of Trihut College of Agriculture research, Dholi, Muzaffarpur (Bihar), during the *rabi* 2022-23. The experiment was carried out in an RBD design with three replications and twelve treatments: Pre-emergence (PE) application of oxyluorfen (150 & 250 g/ha), post-emergence (PoE) application quizalofop-p-ethyl, propaquizafop (20 DAS), topramezone 20.6 g/ha (14 & 21 DAS) and 25.7 g/ha (21 DAS) applied. Among pre + post emergence applications oxyfluorfen (150 g/ha) *fb* quizalofop-p-ethyl (100 g/ha at 15-20 DAS), oxyfluorfenfollowed bypropaquizafop (100 g/ha at 20 DAS) and oxyfluorfen *fb* topramezone (20.6 g/ha at 21 DAS) applied, along with the weed-free control (WFC) and weedy check.

Among all the herbicidal treatments, the combination of oxyfluorfen at 150 g/ha followed by topramezone at 20.6 g/ha at 21 DAS (pre + post-emergence) recorded lowest weed dry matter and highest weed control efficiency (WCE) and crop yield.

**Keywords:** *Topramezone,* quizalofop-p-ethyl, propaquizafop and oxyluorfen

**Introduction**

“Chickpea (*Cicer arietinum* L.) is a crucial pulse crop globally, with Indian subcontinent (India, Pakistan, Myanmar, Bangladesh, and Nepal) the leading producer, contributing to 70% of the world's total output” (Jain *et al,* 2013). “In India, the states of Madhya Pradesh, Rajasthan, Maharashtra, Bihar, Uttar Pradesh, and Gujarat are the primary producers of chickpea. This crop can thrive in a variety of soil types, ranging from light sandy loams to heavier clay soils, and it also has the ability to fix biological nitrogen. However, slow initial growth and limited leaf cover in the early stages of gram, making them highly susceptible to weed competition, which can lead to significant yield losses. The first 30 to 60 days after sowing are particularly critical for weed competition in chickpea” (Kumar and Singh 2010). Effective weed control is essential for the successful cultivation of chickpea, as poor weed management is one of the main factors that limit yield. Manual weeding is labor-intensive and restricts the area that can be cultivated. A suitable herbicide for controlling mixed weed populations in chickpea is pendimethalin, applied as a pre-emergence treatment, which offers effective control during the early stages of crop growth. However, subsequent weed flushes can only be managed using post-emergence herbicides. Therefore, there is a need to identify more efficient herbicides with a broader spectrum of weed control for chickpea. Topramezone, a recently developed selective herbicide with a pyrazole structure, is effective against both broadleaf and narrow-leaf weeds after emergence and is commonly used in maize. The herbicide strongly inhibits the 4-HPPD enzyme, resulting in bleached broadleaf weeds and grasses, eventually causing their death. Given these challenges, this study aims to evaluate the effectiveness of various herbicides for broad-spectrum weed management and their impact on the growth and yield of chickpea.

**Material and methods**

The study was carried out at the agronomical research farm of Trihut College of Agriculture, located in Dholi, Muzaffarpur, Bihar. This farm is situated in the central Indo-Gangetic region, with coordinates at 25° 99' N latitude, 85° 60" E longitude, and an elevation of 52.18 meters above sea level. For analyzing different soil physio-chemical properties, soil samples were randomly collected from farm before sowing. The soil in the field was sandy-loam with low organic carbon (0.45%), available nitrogen (249 kg/ha), phosphorus (17.2 kg/ha), potassium (122 kg/ha), EC 1.10 dS/m, and pH 7.81.

The experiment was designed in randomized block consisted of 12 treatments with replicate thrice, *viz*.*,* Oxyfluorfen 150 and 250 g/ha was sprayed as PE (T1 and T2, respectively), among PoE applications Quizalofop-p-ethyl 100 g/ha and Propaquizafop 100 g/ha (20 DAS), Topramezone 20.6 g/ha (14 and 28 DAS) and Topramezone 25.7 g/ha (21 DAS) was applied. Whereas, pre + post emergence combinations Oxyfluorfen 150 g/ha (PE) *fb* quizalofop-p-ethyl 100 g/ha (15-20 DAS), Oxyfluorfen 150 g/ha *fb* propaquizafop 100 g/ha (20 DAS) and Oxyfluorfen 150 g/ha *fb* topramezone 20.6 g/ha (21 DAS) were applied. Different doses of herbicides were applied according to the pre-planned schedule. The variety of chickpea was GNG-2299 used for sowing.Tthe entire recommended dose of N, P and K (20, 40 and 20 kg/ha, respectively) was applied as a basal dose at the time of field preparation. To record weed dry weight (g/m2), weeds within each square was cut down close to the ground surface, sun dried after washing with tap water and the samples were placed in an oven at 70 °C until a constant weight was achieved. Subsequently, the dried samples were measured and the dry weight was converted to g/m². WCE efficiency calculated from weed dry weight. The grain yield was taken from each plot by 1 m2 area from the centre of each plot and expressed in kg/ha at 12% moisture content. Statistical analysis was done by adopting appropriate method of Analysis of Variance (Gomez and Gomez 1984).

**RESULTS AND DISCUSSION**

**Weed dry matter:** All types of weeds were observed in the research field, including narrow-leaf weeds (NLWs), broad-leaf weeds (BLWs) and sedges (*Mellilotus indica, Chenopodium album, Cannabis sativa, Physalis minima, Alternanthera sessilis, Cynodon dactylon*, *Cyperus rotundus*). Weed dry matter production was significantly reduced by all the weed control treatments. Among them, weed free treatment recorded the lowest weeds dry biomass (g/m²) compared to all other treatments. In contrast, the highest weed dry matter was observed in the unweeded plots. This highlights the effectiveness of the weed control measures in minimizing weed biomass.

Among all herbicidal treatments, Oxyfluorfen 150 g/ha *fb* topramezone 20.6 g/ha at 21 DAS (pre + post) sowing reduced overall weed dry biomass followed by topramezone 20.6 g/ha (21 DAS). However, the application of herbicides had minimal impact on sedges, particularly *Cyperus rotundus*, as it is a perennial weed and notoriously difficult to control. This suggests that while herbicides may effectively manage annual weeds, their efficacy in controlling persistent perennials like *C*. *rotundus* is limited, highlighting the challenges in managing such species. PE application of oxyfluorfen 150 g/ha reduced initial weed germination and later growth stages PoE application of topramezone 20.6 g/ha (21 DAS) suppressed NLWs and BLWs and recorded lower weed dry matter than other. Similarly, Gajanand *et al.* (2023) and Kumar *et al*. (2023) reported topramezone efficiency. Mahto *et al.* (2020) also reported “25.2 g/ha dose of topramezone recorded lowest weed dry weight as compared to other doses”.

**Table 1. Effect of different weed control treatments on weed dry matter, WCE and crop yield**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | | **Seed yield**  **(kg/ha)** | **Weed dry wt. (g/m2)** | **WCE (%)** |
| **T1** | Oxyfluorfen 150 g a.i./ha (pre-emergence) | 1097 | **11.85\*** (140.1) | 28.7 |
| **T2** | Oxyfluorfen 250 g a.i./ha (pre-emergence) | 1035 | **12.11** (146.4) | 25.7 |
| **T3** | Quizalofop-p-ethyl 100 g a.i./ha at 20 DAS (post-emergence) | 875 | **12.42** (154.4) | 22.4 |
| **T4** | Propaquizafop 100 g a.i./ha at 20 DAS (post-emergence) | 934 | **12.07** (145.9) | 26.8 |
| **T5** | Topramezone 20.6 g a.i./ha at 14 DAS (post-emergence) | 994 | **11.45** (130.7) | 33.5 |
| **T6** | Topramezone 20.6 g a.i./ha at 21 DAS (post-emergence) | 1479 | **7.47** (55.4) | 71.1 |
| **T7** | Topramezone 25.7 g a.i./ha at 21 DAS (post-emergence) | 1418 | **7.62** (57.7) | 69.8 |
| **T8** | Oxyfluorfen 150 g a.i./ha *fb* quizalofop-p-ethyl 100 g a.i./ha at 15-20 DAS (pre + post) | 1089 | **10.26** (105.1) | 45.6 |
| **T9** | Oxyfluorfen 150 g a.i./ha *fb* propaquizafop 100 g a.i./ha at 20 DAS (pre + post) | 1146 | **9.50** (90.0) | 53.1 |
| **T10** | Oxyfluorfen 150 g a.i./ha *fb* topramezone 20.6 g a.i./ha at 21 DAS (pre + post) | 1574 | **3.15** (9.4) | 95.1 |
| **T11** | Weedy check | 790 | **14.14** (201.0) | 0.0 |
| **T12** | Weed free check | 1579 | **0.71** (0.0) | 100.0 |
| SEm+ | | 62.21 | 0.39 | **-** |
| CD at 5% | | 182.43 | 1.14 | **-** |

*\*Figures in parentheses () are the actual value of weed dry matter and outside the parentheses are square root () transformed values*

**Weed control efficiency (WCE):** Among all the herbicidal treatments, the combination of oxyfluorfen at 150 g/ha followed by topramezone at 20.6 g/ha at 21 DAS (pre + post-emergence) achieved the highest weed control efficiency (WCE). Additionally, the treatment with topramezone at 20.6 g/ha at 21 DAS also showed a significant level of weed control efficiency (Table 1). These results indicate that this specific combination of herbicides was highly effective in managing weed growth. This can be attributed to the fact that the pre-emergence (PE) application of oxyfluorfen alone did not significantly affect the later stages of weed growth. Among the post-emergence (PoE) treatments, the application of topramezone at 20.6 g/ha at 21 DAS showed the highest weed control efficiency (WCE) compared to all other treatments. This suggests that the post-emergence application of topramezone was more effective in controlling weeds at later growth stages.

**Crop Yield:** All weed control methods had a significant effect on chickpea seed yield. The highest yield was recorded in the weed free treatment, which produced 99% more yield than the weedy check treatment. In contrast, the weedy check resulted in a 50% decrease in crop yield (Table 1). These findings are consistent with the studies of Singh *et al*. (2020), who reported that “weeds reduced chickpea yield by 40-87% on average” and Yadav *et al*. (2019), who observed a “69% reduction in chickpea yield due to weed infestation”.

Among all herbicidal treatments, Oxyfluorfen 150 g/ha *fb* topramezone 20.6 g/ha at 21 DAS (pre + post) yielded 99% more seed yield than weedy check, 43-52% higher than PE of oxyfluorfen (T1 & T2) and 6-80% more than all PoE applied treatment (T3 to T7).

Among all PoE applied herbicides topramezone 20.6 g/ha (21 DAS) increased crop yield 11-69% as compared to other PoE applications. Tiwari *et al*. (2018) reported that “PoE application topramezone at 25.2 g/ha decreased weed growth and enhanced crop yield compared to topramezone at 13.8 g/ha at a lower dose and resulted in a 40.5% greater seed production than the weedy treatment”.

Conclusion

In the realm of herbicide treatments, Among all herbicidal treatments, Oxyfluorfen 150 g/ha *fb* topramezone 20.6 g/ha at 21 DAS (pre + post)was found to be the best treatment for effectively curbing weed growth and bolstering the yield of chickpeas. Furthermore, remarkable results with topramezone (20.6 g/ha) applied at 21 DAS post-emergence for efficiently controlling weed and increase in yield of chickpea.

Authors’ Contributions

Author SK designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. All authors managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript.

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Competing interests

“Authors have declared that no competing interests exist.”

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