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## Efficacy of integrated weed management practices in *rabi* sunflower (*Helianthus annuus*. L)

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### Abstract

A field experiment was conducted at Narkhoda Research Farm, ICAR-IIOR during the *rabi* season of 2024 to evaluate different integrated weed management practices in *rabi* sunflower. The experiment was laid out in a randomized block design with three replications and eight treatments, viz., T<sub>1</sub>: oxyfluorfen 23.5% EC at 100 g a.i. ha<sup>-1</sup> as pre-emergence (PE) *fb* mechanical weeding at 30 DAS; T<sub>2</sub>: pendimethalin 38.7% CS at 677.25 g a.i. ha<sup>-1</sup> as PE *fb* mechanical weeding at 30 DAS; T<sub>3</sub>: pyroxasulfone 85% WG at 127.5 g a.i. ha<sup>-1</sup> as PE *fb* mechanical weeding at 30 DAS; T<sub>4</sub>: metolachlor 50% EC at 1000 g a.i. ha<sup>-1</sup> as PE *fb* mechanical weeding at 30 DAS; T<sub>5</sub>: flumioxazin 50% SC at 125 g a.i. ha<sup>-1</sup> as PE *fb* mechanical weeding at 30 DAS; T<sub>6</sub>: pendimethalin 30% + imazethapyr 2% EC (ready mix) at 562.5 + 37.5 g a.i. ha<sup>-1</sup> as PE *fb* mechanical weeding at 30 DAS; T<sub>7</sub>: weed-free check maintained through inter-row mechanical weeding and intra-row hand weeding at 20 and 40 DAS; and T<sub>8</sub>: unweeded control. Among the herbicidal treatments, pre-emergence application of pyroxasulfone 85% WG at 127.5 g a.i. ha<sup>-1</sup> *fb* mechanical weeding at 30 DAS recorded lower weed density (20.67 m<sup>-2</sup>), which consequently resulted in reduced weed biomass (6.05 g m<sup>-2</sup>), higher weed control efficiency (88.65%), highest seed yield (2424 kg ha<sup>-1</sup>) and stalk yield (5097 kg ha<sup>-1</sup>) among herbicidal treatments.

**Keywords:** Pyroxasulfone, weed management, sunflower

### Introduction

Sunflower (*Helianthus annuus* L.), popularly known as Surajmukhi in India, belongs to the family Asteraceae. Owing to its short life cycle and sensitivity to temperature, the crop can be cultivated across different seasons of the year. Sunflower seeds are widely consumed as food, and the plant is also valued for ornamental purposes. In addition, sunflower finds diverse applications in textile dyeing, body art, and decorative uses. Sunflower oil is regarded as a premium edible oil due to its light colour and high proportion of unsaturated fatty acids, containing approximately 55-65% linoleic acid and 20-30% oleic acid (Joksimovic *et al.*, 2006). Weed interference is one of the most significant biotic stresses affecting sunflower growth and productivity. Among the various agronomic factors limiting yield, weed infestation is considered a major constraint. The relatively slow initial growth of sunflower provides favourable conditions for weed germination and establishment (Reddy *et al.*, 2008) <sup>[14]</sup>. Weeds compete aggressively with the crop for essential resources such as moisture, nutrients, light, and space, leading to substantial reductions in growth and yield potential (Lehoczyk *et al.*, 2006) <sup>[8]</sup>. To minimize yield losses caused by weeds, the judicious use of pre-emergence herbicides needs to be systematically evaluated for effective weed management in sunflower. However, prolonged and continuous reliance on herbicides alone can result in the development of herbicide-resistant weed populations, making weed control increasingly challenging. Therefore, integrating chemical control with mechanical and cultural methods has proven effective in managing predominant weed flora. Integrated Weed Management (IWM), which combines cultural, mechanical and chemical approaches, is considered both environmentally sustainable and economically feasible for sunflower cultivation (Kalaisudarson *et al.*, 2020) <sup>[6]</sup>. In light of these considerations, the present study was undertaken to assess the performance of alternate and promising new herbicides in combination with mechanical weed control, with the objective of achieving effective weed management during the critical period of crop-weed competition in

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sunflower.

## Materials and Methods

The field experiment was carried out during the *rabi* season of 2024 at the Narkhoda Research Farm of the ICAR-Indian Institute of Oilseed Research (IIOR), Hyderabad. The experimental site is geographically located at 17°15'16" N latitude and 78°18'30" E longitude, with an elevation of 542 m above mean sea level. The sunflower variety Tilhan Tech SUNFH-1 was used for the study, sown at a seed rate of 5 kg ha<sup>-1</sup> with a spacing of 60 cm × 30 cm. The experiment was laid out in a randomized block design (RBD) comprising eight treatments and three replications. The treatments included different pre-emergence herbicides followed by mechanical weed control. Treatment details were as follows: T<sub>1</sub>: oxyfluorfen 23.5% EC at 100 g a.i. ha<sup>-1</sup> as PE fb mechanical weeding at 30 DAS; T<sub>2</sub>: pendimethalin 38.7% CS at 677.25 g a.i. ha<sup>-1</sup> as PE fb mechanical weeding at 30 DAS; T<sub>3</sub>: pyroxasulfone 85% WG at 127.5 g a.i. ha<sup>-1</sup> as PE fb mechanical weeding at 30 DAS; T<sub>4</sub>: metolachlor 50% EC at 1000 g a.i. ha<sup>-1</sup> as PE fb mechanical weeding at 30 DAS; T<sub>5</sub>: flumioxazin 50% SC at 125 g a.i. ha<sup>-1</sup> as PE fb mechanical weeding at 30 DAS; T<sub>6</sub>: pendimethalin 30% + imazethapyr 2% EC (ready mix) at 562.5 + 37.5 g a.i. ha<sup>-1</sup> as PE fb mechanical weeding at 30 DAS; T<sub>7</sub>: weed-free check maintained through inter-row mechanical weeding and intra-row hand weeding at 20 and 40 DAS; and T<sub>8</sub>: unweeded control. Herbicides were applied using a flat-fan nozzle sprayer, while mechanical weeding was performed using a star weeder. Weed control efficiency was calculated using following formula suggested by Mishra and mishra (1997) <sup>[11]</sup>,

$$\text{Weed control efficiency (WCE)} = \frac{X - Y}{X} \times 100$$

Where,

X=weed dry matter in weedy check (g). Y= weed dry matter in respective treatment (g).

Weed index was calculated using the formula suggested by Gill (1969) <sup>[12]</sup>,

$$\text{Weed index (WI)} = \frac{X - Y}{X} \times 100$$

Where,

X=crop yield from weed free plot. Y=crop yield from the treated plot. Yield parameters and yield of sunflower were recorded by harvesting the net plot.

Statistical analysis of the data collected on weeds and the castor crop was conducted using the Analysis of Variance (ANOVA) technique at  $p \leq 0.05$  under a Randomized Block Design, as described by Gomez and Gomez (1984) <sup>[3]</sup>.

## Results and Discussion

### Weed flora

Among the grasses, *Cynodon dactylon* and *Digitaria sanguinalis* remained dominant throughout the crop growth period. *Dinebra retroflexa* appeared at 60 DAS and continued until harvest, while *Echinochloa colona* was observed only at the harvest stage. Among sedges, *Cyperus rotundus* was consistently present across all stages of crop growth, reflecting its perennial and persistent nature. Broad-leaved weeds recorded during the entire crop duration included *Digera arvensis*, *Tridax procumbens*, *Portulaca oleracea*, *Boerhavia erecta*,

*Trichodesma indicum*, *Commelina benghalensis* and *Phyllanthus niruri*. The composition of weed flora observed in the present study is in agreement with earlier findings reported by Mishra (2020) <sup>[10]</sup> and Narender *et al.* (2017) <sup>[12]</sup> in sunflower, and Lenka *et al.* (2023) <sup>[9]</sup> in groundnut.

### Weed density and biomass

Weed-free treatment recorded the lowest weed density (0.00 m<sup>-2</sup>) and biomass (0.00 g m<sup>-2</sup>), followed by application of pyroxasulfone 85% WG at 127.5 g a.i. ha<sup>-1</sup> fb mechanical weeding at 30 DAS (20.67 m<sup>-2</sup>, 6.05 g m<sup>-2</sup> respectively). Application of pyroxasulfone at 127.5 g a.i. ha<sup>-1</sup> as a pre-emergence herbicide proved highly effective in controlling various categories of weeds, including perennial sedges such as *Cyperus rotundus* and broad-leaved weeds in sunflower. The comparatively lower total weed density and biomass observed under pyroxasulfone treatment may be attributed to its inhibition of very longchain fatty acid (VLCFA) synthesis, resulting in suppression of early weed emergence. Similar reductions in weed density with pyroxasulfone were also reported by Ramesh *et al.* (2025) <sup>[13]</sup> in sesame.

### Weed control efficiency

Weed control efficiency (WCE) indicated the extent to which weed control treatments reduced weed biomass compared to the unweeded control. Weed control efficiency (WCE) was significantly affected by the different weed control treatments. Maximum weed control efficiency (WCE) (100%) was observed under the weed-free treatment which was followed by the application of pyroxasulfone 85% WG at 127.5 g a.i. ha<sup>-1</sup> fb mechanical weeding at 30 DAS (88.65%). The higher WCE under these treatments can be attributed to effective control of the initial flush of weeds by the herbicide, while subsequent weed emergence was managed through intercultivation. The greater reduction in weed dry weight observed under this treatment due to lower weed density might have contributed to a higher weed control efficiency (WCE). Similar findings were reported by Yamaji *et al.* (2014) <sup>[16]</sup>.

### Phytotoxicity

The pre-emergence application of flumioxazin was found to be highly phytotoxic to sunflower, with an initial crop injury rating of 8. The treated plants exhibited stunting, which persisted throughout the crop growth period. Similarly, Kurtenbach *et al.* (2019) <sup>[7]</sup> reported phytotoxicity of flumioxazin in flax.

### Seed yield and stalk yield

Significantly the highest seed yield (2536 kg ha<sup>-1</sup>) and stalk yield (5282 kg ha<sup>-1</sup>) of sunflower were obtained with weed free treatment which was statistically at par with pyroxasulfone 85% WG at 127.5 g a.i. ha<sup>-1</sup> fb mechanical weeding at 30 DAS (2424, 5097 kg ha<sup>-1</sup> respectively). Application of pyroxasulfone as pre-emergence resulted in effective control of weeds minimizing the crop weed competition, no phytotoxicity and effective translocation of photosynthates from source to sink resulting from the effective utilization of growth resources. These findings are in line with Arvind *et al.* (2025) <sup>[1]</sup> in soybean and Rekhasree *et al.* (2025) <sup>[15]</sup> in sesame. The highest yield in weed free treatment might be due to the maintenance of weed free conditions throughout the growth period which reduced crop-weed competition and resulted in higher yields. This was similar to the findings of Hans *et al.* (2018) <sup>[4]</sup> in sunflower. Significantly lowest yield was obtained in flumioxazin 50% SC at 125 g a.i. ha<sup>-1</sup> as PE fb mechanical weeding at 30 DAS which

might be due to phytotoxic effect.

### Harvest index

The harvest index of sunflower was not significantly affected by the different weed management treatments. However, the

highest harvest index was recorded in the weed-free treatment (inter-row mechanical weeding combined with intra-row hand weeding at 20 and 40 DAS) (32.44), whereas the lowest value was observed in the unweeded control (27.92).

**Table 1:** Weed density, weed biomass, weed control efficiency (WCE), phytotoxicity rating, seed and stalk yield of sunflower as influenced by different integrated weed management practices

|                | Treatments                                                                                                                       | Weed density<br>(No m <sup>-2</sup> ) | Weed biomass<br>(g m <sup>-2</sup> ) | WCE<br>(%) | Phytotoxicity<br>rating | Seed yield<br>(kg ha <sup>-1</sup> ) | Stalk<br>yield<br>(kg ha <sup>-1</sup> ) | Harvest<br>index |
|----------------|----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|--------------------------------------|------------|-------------------------|--------------------------------------|------------------------------------------|------------------|
| T <sub>1</sub> | Oxyfluorfen 23.5% EC at 100 g a.i ha <sup>-1</sup> as PE fb Mechanical weeding at 30 DAS                                         | 6.11<br>(37.00)                       | 3.64<br>(12.88)                      | 75.93      | 0.0                     | 2054                                 | 4503                                     | 31.31            |
| T <sub>2</sub> | Pendimethalin 38.7% CS at 677.25 g a.i ha <sup>-1</sup> as PE fb Mechanical weeding at 30 DAS                                    | 5.67<br>(31.67)                       | 3.08<br>(10.80)                      | 79.92      | 0.0                     | 2206                                 | 4801                                     | 31.48            |
| T <sub>3</sub> | Pyroxasulfone 85% w/w WG at 127.5 g a.i ha <sup>-1</sup> as PE fb Mechanical Weeding at 30 DAS                                   | 4.59<br>(20.67)                       | 2.55<br>(6.05)                       | 88.65      | 0.0                     | 2424                                 | 5097                                     | 32.23            |
| T <sub>4</sub> | Metolachlor 50% EC at 1000 g a.i ha <sup>-1</sup> as PE fb Mechanical weeding at 30DAS                                           | 6.44<br>(41.00)                       | 3.98<br>(15.58)                      | 70.91      | 0.0                     | 1966                                 | 4381                                     | 30.95            |
| T <sub>5</sub> | Flumioxazin 50% SC at 125 g a.i ha <sup>-1</sup> as PE fb Mechanical weeding at 30 DAS                                           | 6.19<br>(38.00)                       | 3.88<br>(14.76)                      | 72.34      | 8.0                     | 385                                  | 876                                      | 30.53            |
| T <sub>6</sub> | Pendimethalin 30% + Imazethapyr 2% EC (ready mix) at (562.5 + 37.5) g a.i ha <sup>-1</sup> as PE fb Mechanical weeding at 30 DAS | 6.33<br>(39.67)                       | 3.95<br>(15.33)                      | 71.36      | 0.0                     | 2001                                 | 4436                                     | 31.08            |
| T <sub>7</sub> | Weed free (Inter row mechanical weeding+ Intra row hand weeding) at 20 and 40 DAS                                                | 0.71<br>(0.00)                        | 0.71<br>(0.00)                       | 100.00     | 0.0                     | 2536                                 | 5282                                     | 32.44            |
| T <sub>8</sub> | Unweeded check                                                                                                                   | 10.20<br>(103.67)                     | 7.32<br>(53.09)                      | 0.00       | 0.0                     | 809                                  | 2111                                     | 27.92            |
|                | SEm ±                                                                                                                            | 0.12                                  | 0.16                                 | 75.93      | -                       | 44.7                                 | 96.4                                     | 0.86             |
|                | CD (p=0.05)                                                                                                                      | 0.36                                  | 0.49                                 | 79.92      | -                       | 135.5                                | 292.3                                    | NS               |

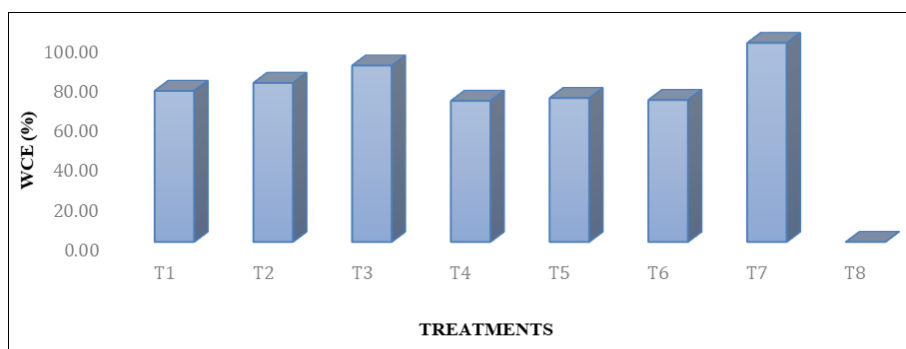


**Fig 1:** Effect of integrated weed management practices on WCE (%) of *rabi* sunflower.

### Conclusion

Based on the results it can be concluded that among the herbicidal treatments, pre-emergence application of pyroxasulfone 85% WG at 127.5 g a.i. ha<sup>-1</sup> followed by mechanical weeding at 30 DAS resulted in lowest weed density (20.67 m<sup>-2</sup>), lowest weed biomass (6.05 g m<sup>-2</sup>), highest WCE (88.65%), highest seed yield (2424 kg ha<sup>-1</sup>), stalk yield (5097 kg ha<sup>-1</sup>) and HI (32.23). Thus, pre-emergence application of pyroxasulfone 85% WG at 127.5 g a.i. ha<sup>-1</sup> followed by mechanical weeding at 30 DAS can be safely applied to sunflower for higher yield in *rabi* sunflower in Southern Telangana Zone of Telanagana.

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