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RESEARCH ARTICLE

Evaluation of isoxaflutole and thiencarbazone–methyl for the management of itchgrass [*Rottboellia cochinchinensis* (Lour.) Clayton] in maize

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ABSTRACT

Itchgrass [*Rottboellia cochinchinensis* (Lour.) Clayton] is a highly invasive annual grass, ranked among the world's most troublesome weeds. In Karnataka, and in many other states of India, it poses a serious threat to maize and other crops across major maize-growing regions. As most herbicides have shown limited efficacy against this weed, a field study was conducted with an objective to study the effect of isoxaflutole + thiencarbazone-methyl for the management of *R. cochinchinensis* in maize. It was conducted during *Kharif* 2023 and 2024 at a farmer's field in Pura village, Manchenahalli hobli, Gauribidanur taluk, Chikkaballapura district, Karnataka. The evaluated weed management options include: the pre-emergence application (PE) and early post-emergence application (EPoE) of isoxaflutole 225 g/L + thiencarbazone-methyl 90 g/L SC (isoxaflutole + thiencarbazone-methyl) (ready- mix) 73.12+29.25 and 90+36 g/ha, atrazine 50% WP (atrazine) 1000 g/ha PE, and topramezone 336 g/L w/v SC (topramezone) 33.6 g/ha + adjuvant 2 ml/L of water EPoE, hand weeded thrice at 20, 40, and 60 days after seeding (DAS) (weed-free) and an untreated control. The isoxaflutole + thiencarbazone-methyl provided superior control of *R. cochinchinensis* and most associated weed species, except *Cyperus rotundus*. Isoxaflutole + thiencarbazone-methyl (ready- mix) at both 73.12+29.25 and 90+36 g/ha PE and EPoE, consistently achieved the highest weed control efficiency, maximum maize grain and straw yield, and the lowest weed index demonstrating that it has a highly effective and promising option for managing *R. cochinchinensis* in maize.

Keywords: Itchgrass, Isoxaflutole, *Rottboellia cochinchinensis*, Thiencarbazone–methyl, Maize, Weed management

INTRODUCTION

Maize (*Zea mays* L.) is one of the world's most important cereal crops, serving as a staple food, a vital feed source for livestock, and a key raw material for various agro-industries. In India, maize is cultivated on approximately 11.24 million hectares, producing 37.66 million tons with an average productivity of 3.35 t/ha (Anonymous 2023–24). In Karnataka produces 5.63 million tons of maize from an area of 1.97 million hectares and productivity of 2.89 t/ha, which is, notably lower than the national average maize productivity. Over the past decade, maize cultivation in Karnataka has expanded more rapidly than other crops, increasingly replacing traditional rainfed crops such as potato, tobacco, cotton, groundnut, finger millet (ragi), and sorghum (Prakash and Venkataramana 2023). A major challenge in the state's Karnataka's maize production is the prevalence of itchgrass (*Rottboellia cochinchinensis* (Lour.) Clayton) weed, particularly in the central districts. The regions in Karnataka, such as Shimoga, Davangere, and Chitradurga with reported *R. cochinchinensis* infestations affecting nearly 50–60% of the sown area. *Rottboellia cochinchinensis*, a member of the family Poaceae, is among the most aggressive and destructive invasive weeds impacting tropical and subtropical agriculture. Native to the old world tropics, it has now spread extensively, infesting major crops such as maize, rice, sugarcane, soybean, cotton, and peanut (Anusha *et al.* 2023). Yield losses caused by this weed can be severe, up to 90% in maize (Pannacci and Onofri 2016), with other studies reporting reductions of 50% (Abouziena *et al.* 2013) and 33.7% (Saudy 2013) due to competition. Its invasiveness is attributed to strong competitive ability for essential resources and allelopathic effects (Kobayashi *et al.* 2008, Meksawat and Pornprom 2010). Moreover, its adaptability to diverse environmental conditions enhances its persistence, making management particularly difficult (Strahan *et al.* 2000, Fuhrer 2003, Chauhan 2012).

Rottboellia cochinchinensis infestations have persistently hindered maize from realizing its full yield potential. Weeds affect crop performance through intense competition and allelopathic interactions, leading to considerable reductions in both yield

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quantity and quality (Ramesh *et al.* 2017). Because *R. cochinchinensis* exhibits tolerance to several herbicides, its effective management remains a significant challenge. Hence, it is essential to develop sustainable management strategies aimed at minimizing yield losses by *R. cochinchinensis* and enhancing productivity in maize-based systems of Karnataka and similar agro-climatic regions. Hence, the present study was undertaken to identify an effective herbicide weed management option for controlling *R. cochinchinensis* in maize.

MATERIAL AND METHODS

The present experiment was conducted in association with University of Agricultural Sciences, Bengaluru during *Kharif* 2023 and 2024 under rainfed conditions at Pura village, Manchenahalli hobli, Gauribidanur taluk, Chikkaballapura district, Karnataka (13°56' N latitude and 77°55' E longitude). The mean monthly minimum temperature ranges from 17.2-19.9°C, while the mean monthly maximum temperature ranges from 26.3-30.9°C from August to December. During the experimental periods, the rainfall totals were 348.4 mm in 2023 and 912.8 mm in 2024. The experiment was laid out in a randomized block design (RBD) with eight treatments replicated three times. The tested treatments include: untreated control, pre-emergence application (PE) of isoxaflutole 225 g/L + thiencarbazone-methyl 90 g/L SC (ready-mix) (isoxaflutole + thiencarbazone-methyl) 73.12+29.25 g/ha and 90+36 g/ha, atrazine 50% WP (atrazine) 1000 g/ha PE, early post-emergence application (EPoE) of isoxaflutole + thiencarbazone-methyl 73.12+29.25 g/ha and 90+36 g/ha, topramezone 336 g/L w/v SC (topramezone) + adjuvant 33.6 g/ha + MSO 2 ml/L of water EPoE, and hand weeded thrice at 20, 40, and 60 days after seeding (DAS) (weed free). The maize crop was raised following the recommended package of practices with 20 kg/ha of Pioneer 3302 hybrid in the first week of August in both years. The crop was applied with 150 kg N, 75 kg P and 40 kg K/ha. The entire dose of P and K were applied at sowing, while N (urea) was top-dressed in three splits at 20, 40 DAS and tasseling stages. Herbicides were applied using a knapsack sprayer fitted with a flood-jet nozzle, delivering 500 L water/ha. Pre-emergence applications were made 3DAS, while early post-emergence applications were made on the 12^{th} DAS. Species-wise weed counts were recorded before the EPoE herbicide spray, and subsequently at 28, 42 and 56 days after herbicide spray (DAHS). Species-wise weed dry weight (weed biomass) was measured at 56 DAHS from three randomly selected spots per plot using a 1 m × 1 m quadrat. The collected data were statistically analyzed using square root transformation ($\sqrt{x+0.5}$). Weed density at 28, 42 and 56 DAHS and weed control efficiency (WCE) at 56 DAHS were computed. Crop yield was recorded at harvest, and the weed index was calculated accordingly.

Absolute Frequency (Prashanth *et al.* 2024)

$$\text{Absolute frequency} = \frac{\text{Number of quadrats in which species occured}}{\text{Total number of quadrats}} \times 100$$

Relative frequency (Prashanth *et al.* 2024)

$$\text{Relative frequency} = \frac{\text{Absolute frequency of an indiviual species}}{\text{Abolute frequency of all species}} \times 100$$

Absolute density (Prashanth *et al.* 2024)

$$\text{Absolute density} = \frac{\text{Total number of indiviuals of a species}}{\text{Total number of quadrants}} \times 100$$

Weed control efficiency (WCE) was calculated using the formula (Singh *et al.* 2017)

$$\text{WCE}(\%) = \frac{\text{Dry weight of weeds in untreated control} - \text{Dry weight of weeds in treated plots}}{\text{Dry weight of weeds in untreated control}} \times 100$$

Relative weed density was computed using the formula (Krishnamurty *et al.* 1975)

$$\text{Relative weed density} = \frac{\text{Number of indiviuals of same weed species}}{\text{Number of indiviuals of all weed species}} \times 100$$

Weed index (WI) was derived using the formula (Prachand *et al.* 2015)

$$\text{WI}(\%) = \frac{\text{Yield in weed free plot} - \text{Yield of the treatment}}{\text{Yield in weed free plot}} \times 100$$

The data collected over two years were subjected to analysis of variance (ANOVA) using the F-test, as outlined by Gomez and Gomez (1984). Significant differences among treatment means were compared using the least significant difference (LSD) at the 5% level of significance.

RESULTS AND DISCUSSION

Crop phyto-toxicity ratings

Visual observations on crop phyto-toxicity were recorded at 5, 10, 15, 20, and 25 DAHS. Symptoms such as yellowing, stunting, necrosis, epinasty, hyponasty, and leaf scorching were carefully monitored. No prominent phytotoxic effects were observed across treatments. However, application of isoxaflutole + thiencarbazone–methyl at higher dose (90+36 g/ha) PE and EPoE, induced slight yellowing of leaves up to 10 DAHS. This effect was transient, as the crop exhibited normal growth thereafter with no visible toxicity in the subsequent growth (**Table 1**). These observations are consistent with the findings of Idziak *et al.* (2022), who also reported the absence of phytotoxic effects in maize treated with isoxaflutole + thiencarbazone–methyl at the recommended dose, either pre- or post-emergence.

Effect on weeds

A total of eight weed species were dominant in experimental plots. This included sedge: *Cyperus rotundus*; grasses: *Eleusine indica*, *Rottboellia cochinchinensis*, and *Dactyloctenium aegyptium* and broad-leaved weeds: *Portulaca oleracea*, *Ageratum conyzoides*, *Commelina benghalensis*, and *Parthenium hysterophorus*.

During both *Kharif* 2023 and 2024, *R. cochinchinensis* exhibited the highest relative frequency (69.44% and 66.55%, respectively), confirming its dominance within the weed community. Correspondingly, its absolute frequency, absolute density, and relative frequency values were the highest, further substantiating the predominance of *R. cochinchinensis* in the experimental area (**Figure 1**). The next most dominant species, *Eleusine indica*, also recorded higher absolute frequencies of 87.50% and 91.67% during 2023 and 2024, respectively. A higher absolute frequency reflects a species' widespread and consistent occurrence across the study area, providing valuable insights into its population dynamics, special distribution, and influence on overall weed community structure.

At 28 DAHS (**Table 2)** and 42 DAHS (**Table 3)**, all herbicide-treated plots recorded significantly lower weed density of all weed species compared to the untreated control. At 28 DAHS, isoxaflutole + thiencarbazone–methyl at 73.12+29.25 and 90+36 g/ha PE and EPoE reduced the density of *R. cochinchinensis* by 70.85% to 78.66% relative to the untreated check. In contrast, atrazine PE resulted in only 43.35% - 44.00% reduction. Isoxaflutole + thiencarbazone–methyl EPoE consistently achieved lower weed density of all recorded species compared to pre-emergence treatments.

At 42 DAHS, isoxaflutole + thiencarbazone–methyl, applied either PE or EpoE at 90+36 g/ha, recorded the lowest density of grasses and broad-leaved weeds. However, the density of *Cyperus*

Table 1. Phytotoxicity to maize due to pre-emergence application (PE) and early post-emergence application (EPoE) of isoxaflutole + thiencarbazone–methyl (pooled data of two years)

Treatment	Yellowing DAHS					Stunting DAHS					Necrosis DAHS					Hyponasty / epinasty DAHS					Scorching DAHS				
	5	10	15	20	25	5	10	15	20	25	5	10	15	20	25	5	10	15	20	25	5	10	15	20	25
Untreated control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – PE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – PE	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha - EPoE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – EPoE	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Based on 0-10 scale (0=00, 1=1-10%, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9=81-90%, 10=91-100%)

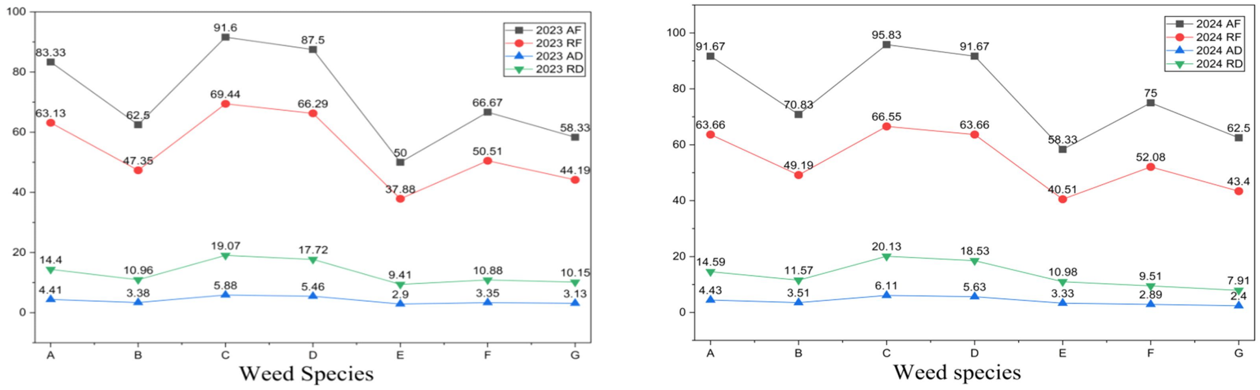

Figure 1. Initial absolute frequency, relative frequency, absolute density and relative density of individual weed species
***AF**- Absolute frequency (%), **RF**-Relative frequency (%), **AD –** Absolute density, **RD-** Relative density (%), A – *Cyperus rotundus*, B – *Dactyloctenium aegyptium*, C – *Rottboellia cochinchinensis*, D – *Eleusine indica*, E –*Commelina benghalensis*, F – *Portulaca oleracea*, G – *Ageratum conyzoides*

Table 2. Effect of different herbicides on major weed species density (no./m²) at 28 days after herbicide application in maize (pooled data *Kharif* 2023 and 2024)

Treatment	*C. rotundus*	*D. aegyptium*	*R. cochinchinensis*	*E. indica*	*C. benghalensis*	*P. oleracea*	*A. conyzoides*	*P. hysterophorus*
Untreated control	4.55 (20.21)*	4.52 (20.00)	5.45 (29.20)	4.43 (19.11)	4.18 (17.00)	4.05 (15.96)	4.18 (17.04)	3.48 (11.68)
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – PE	3.37 (10.87)	3.14 (9.44)	3.00 (8.51)	3.39 (11.00)	2.83 (7.67)	2.79 (7.30)	2.77 (7.18)	2.48 (5.65)
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – PE	3.18 (9.65)	2.99 (8.43)	2.82 (7.49)	3.08 (9.00)	2.73 (7.00)	2.52 (5.94)	2.51 (5.83)	2.23 (4.49)
Atrazine - PE 1000 g/ha	3.50 (11.80)	3.23 (9.92)	4.12 (16.54)	3.41 (11.11)	2.96 (8.33)	2.89 (7.83)	3.02 (8.60)	2.60 (6.29)
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – EPoE	3.13 (9.29)	2.91 (7.95)	2.76 (7.12)	3.06 (8.89)	2.55 (6.00)	2.48 (5.84)	2.59 (6.23)	2.25 (4.56)
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – EPoE	2.96 (8.27)	2.82 (7.45)	2.59 (6.23)	3.03 (8.67)	2.60 (6.33)	2.37 (5.29)	2.50 (5.74)	2.06 (3.76)
Topramezone + adjuvant 33.6 g/ha + MSO 2 ml/L of water -EPoE	3.36 (10.83)	3.12 (9.23)	4.10 (16.35)	3.37 (10.89)	2.90 (8.00)	2.83 (7.54)	2.81 (7.42)	2.49 (5.72)
Hand weeding - 20, 40 and 60 days after seeding (weed free)	1.64 (2.20)	1.61 (2.35)	1.80 (2.75)	1.78 (2.67)	1.22 (1.00)	1.77 (2.76)	1.80 (2.75)	1.80 (2.86)
LSD (p=0.05)	0.30	0.48	0.24	0.28	0.36	0.43	0.24	0.35

* Figures in the parentheses are original value and outside values are square root transformed at $\sqrt{x+0.5}$; PE = pre-emergence application; EPoE = early post-emergence application

Table 3. Effect of different herbicides on major weed species density (no./m²) at 42 days after herbicide application in maize (pooled data *Kharif* 2023 and 2024)

Treatment	*C. rotundus*	*D. aegyptium*	*R. cochinchinensis*	*E. indica*	*C. benghalensis*	*P. oleracea*	*A. conyzoides*	*P. hysterophorus*
Untreated control	4.96 (24.40)*	4.55 (20.26)	5.58 (30.70)	4.64 (21.04	4.45 (19.33)	4.19 (17.11)	4.19 (17.07)	3.61 (12.62)
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – PE	4.20 (17.17)	3.21 (9.82)	3.07 (8.95)	3.46 (11.47	3.29 (10.33)	2.84 (7.57)	2.80 (7.40)	2.53 (5.93)
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – PE	4.11 (16.48)	3.05 (8.82)	2.87 (7.77)	3.25 (10.10	3.02 (8.67)	2.64 (6.49)	2.56 (6.05)	2.37 (5.10)
Atrazine - PE 1000 g/ha	4.34 (18.36)	3.33 (10.64)	4.46 (19.44)	3.59 (12.41	3.29 (10.33)	2.98 (8.38)	3.09 (9.04)	2.74 (7.01)
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – EPoE	4.06 (15.96)	2.95 (8.23)	2.85 (7.62)	3.27 (10.23)	3.12 (9.33)	2.58 (6.23)	2.68 (6.67)	2.33 (4.95)
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – EPoE	3.98 (15.44)	2.89 (7.89)	2.71 (6.90)	3.06 (8.88)	3.01 (8.67)	2.49 (5.68)	2.56 (6.07)	2.19 (4.31)
Topramezone + adjuvant 33.6 g/ha+ MSO 2 ml/L of water -EPoE	4.19 (17.15)	3.24 (10.01)	4.27 (17.90)	3.48 (11.72)	3.69 (13.33)	2.87 (7.76)	2.97 (8.36)	2.63 (6.44)
Hand weeding - 20, 40 and 60 days after seeding (weed free)	1.33 (1.30)	1.26 (1.08)	1.36 (1.36)	1.53 (1.86)	1.58 (2.00)	1.36 (1.36)	1.52 (1.86)	1.65 (2.24)
LSD (p=0.05)	0.40	0.24	0.36	0.28	0.53	0.21	0.29	0.34

*Figures in the parentheses are original value and outside values are square root transformed at $\sqrt{x+0.5}$
PE = pre-emergence application; EPoE = early post-emergence application

rotundus showed minimal variation across treatments, indicating limited efficacy of the herbicide mixture against the species. Overall, the findings demonstrated the superior performance of isoxaflutole + thiencarbazone–methyl, particularly with EPoE, for effective control of diverse weed flora, including *R. cochinchinensis*.

Pooled analysis indicated that weed biomass was significantly influenced by different herbicidal treatments (**Table 4**). At 56 DAHS, the lowest biomass of *R. cochinchinensis* was recorded in isoxaflutole + thiencarbazone–methyl 73.12+29.25 or 90+36 g/ha PE, corresponding to a 7.0% - 17.6% reduction compared with atrazine. The same herbicide mixture EPoE reduced *R. cochinchinensis* biomass by 2.34% - 13.23% relative to atrazine. Overall, herbicidal mixtures effectively suppressed weed growth and infestation, leading to a substantial reduction in weed biomass as reported by Patel *et al.* (2006).

Total weed biomass was also significantly influenced by herbicide treatments (**Figure 2**). At 56 DAHS, isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha and 90+36 g/ha EPoE recorded the lowest weed biomass. Aref *et al.* (2017) observed significant reductions in grassy weed biomass in maize with isoxaflutole + thiencarbazone–methyl.

Weed control efficiency (WCE) for individual weed species was calculated based on their dry weight at 56 DAHS (**Table 5**). For *R. cochinchinensis*, WCE exceeded 90% with isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/

Table 4. Effect of different herbicides on major weed dry weight (g/m^2) at 56 days after herbicide application in maize (pooled data *Kharif* 2023 and 2024)

Treatment	*C. rotundus*	*D. aegyptium*	*R. cochinchinensis*	*E. indica*	*C. benghalensis*	*P. oleracea*	*A. conyzoides*	*P. hysterophorus*
Untreated control	3.85 (14.45)	4.12 (16.44)	6.83 (46.18)	4.35 (18.45)	4.82 (22.75)	4.70 (21.59)	4.27 (17.82)	3.63 (12.67)
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – PE	3.22 (9.90)	2.34 (5.01)	2.82 (7.49)	2.27 (4.69)	2.55 (6.02)	2.50 (5.75)	2.33 (4.96)	2.08 (3.82)
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – PE	2.85 (7.69)	2.24 (4.50)	2.15 (4.15)	2.18 (4.24)	2.49 (5.70)	2.37 (5.10)	2.11 (3.96)	1.93 (3.23)
Atrazine - PE 1000 g/ha	3.07 (8.93)	2.55 (5.98)	3.57 (12.28)	2.59 (6.21)	2.88 (7.82)	3.00 (8.51)	2.57 (6.11)	2.30 (4.81)
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – EPoE	2.71 (6.86)	2.16 (4.16)	2.13 (4.02)	2.11 (3.95)	2.31 (4.84)	2.26 (4.63)	2.07 (3.81)	1.85 (2.91)
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – EPoE	2.55 (6.01)	2.11 (3.96)	2.03 (3.61)	2.07 (3.80)	2.24 (4.54)	2.21 (4.38)	2.02 (3.56)	1.76 (2.61)
Topramezone + adjuvant 33.6 g/ha+ MSO 2 ml/L of water -EPoE	3.19 (9.73)	2.36 (5.08)	3.20 (9.72)	2.30 (4.87)	2.53 (5.92)	2.51 (5.78)	2.31 (4.84)	2.00 (3.49)
Hand weeding - 20, 40 and 60 days after seeding (weed free)	0.87 (0.26)	1.08 (0.66)	1.15 (0.82)	1.24 (1.06)	1.56 (1.95)	1.37 (1.39)	1.12 (0.75)	1.16 (0.86)
LSD (p=0.05)	NS	0.11	0.19	0.29	0.17	0.15	0.22	0.16

Table 5. Effect of weed management practices on weed control efficiency at 56 days after herbicide application, grain yield and weed index in maize (pooled data *Kharif* 2023 and 2024)

Treatment	Weed control efficiency (%)								Grain yield (t/ha)	Weed index (%)
	C. rotundus	*D. aegyptium*	*R. cochinchinensis*	*E. indica*	*C. benghalensis*	*P. oleracea*	*A. conyzoides*	*P. hysterophorus*		
Untreated control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.09	40.79
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – PE	31.48	69.54	83.78	74.61	73.54	73.38	72.18	69.89	7.40	13.91
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – PE	46.79	72.61	91.02	77.04	74.93	76.36	77.77	74.51	7.86	8.59
Atrazine - PE 1000 g/ha	38.21	63.63	73.42	66.37	65.63	60.59	65.70	62.08	6.68	22.34
Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha – EPoE	52.51	74.73	91.29	78.60	78.73	78.55	78.65	77.06	7.87	8.51
Isoxaflutole + thiencarbazone–methyl 90+36 g/ha – EPoE	58.41	75.89	92.18	79.41	80.04	79.73	80.00	79.44	7.91	8.02
Topramezone + adjuvant 33.6 g/ha+ MSO 2 ml/L of water -EPoE	32.65	69.11	78.95	73.59	73.99	73.24	72.82	72.49	6.98	18.88
Hand weeding - 20, 40 and 60 days after seeding (weed free)	98.19	95.99	98.23	94.24	91.41	93.55	95.79	93.25	8.60	0.00

*PE = pre-emergence application; EPoE = early post-emergence application

ha and 90+36 g/ha PE and EPoE. In contrast, atrazine exhibited comparatively lower efficiency in managing all weed species. For the remaining weed species, the pre-mixed formulation of isoxaflutole + thiencarbazone–methyl also achieved higher WCE values, ranging from 58.41-80.04% (**Figure 3**). However, its efficiency against *Cyperus rotundus* remained below 60%, indicating limited control of this species as reported by Idziak *et al.* (2022).

Effect on maize

Isoxaflutole + thiencarbazone–methyl 90 + 36 g/ha PE and EPoE resulted in significantly higher maize grain yield (**Table 5**). Next best was same herbicide at 73.12 + 29.25 g/ha, compared to other treatments confirming the results of Stephenson and Bond (2012) in maize and Idziak *et al.* (2022) in sweet corn.

The weed index, representing the reduction in crop yield due to weed interference compared to the weed-free treatment, was highest under the weedy check (40.79%). Conversely, the lowest weed index values (8.02% - 13.91%) were recorded with isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha and 90+36 g/ha PE and EPoE. The reduced weed index under these treatments attributed to higher maize yields which was achieved due to effective control of *R. cochinchinensis* and other associated weed species.

Conclusions

Isoxaflutole + thiencarbazone–methyl 73.12+29.25 g/ha and 90+36 g/ha PE and EPoE effectively controlled *R. cochinchinensis* and most associated weed species, with the exception of *C. rotundus*. At the higher dose of 90+36 g/ha, slight phytotoxic symptoms were observed on maize shortly after application; however, the crop recovered completely within 10 days, indicating only transient injury. Isoxaflutole + thiencarbazone–methyl

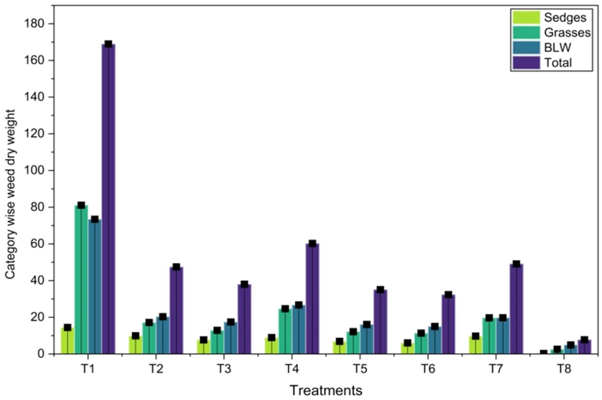

Figure 2. Effect of weed management treatments on weed biomass in maize at 56 DAHS

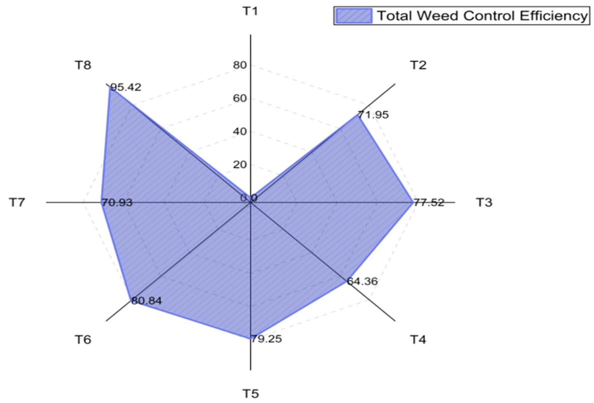

Figure 3. Effect of weed management treatments on WCE (%) in maize at 56 DAHS

73.12+29.25 g/ha PE and EPoE was found effective in managing *Rottboellia cochinchinensis* and other weed species and it consistently achieved superior weed control efficiency, enhanced maize grain yield, and a reduced weed index relative to other herbicidal treatments, thereby confirming its effectiveness and crop safety under field conditions.

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