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Efficacy of new generation herbicide mixtures in irrigated maize (*Zea mays*)

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ABSTRACT

The experiment was conducted during rainy (*kharif*) seasons of 2020 and 2021 at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu to study the efficacy of new generation herbicide mixtures in irrigated maize (*Zea mays* L.). The experiment was laid out in a randomized complete block design (RCBD) consisted of 9 treatments including pre-emergence herbicides, new generation post emergence herbicides and other weed management practices [T_1, Weedy check; T_2, Weed free check; T_3, Spraying of atrazine @1 kg/ha as pre-emergence + Hand weeding on 25 DAS (days after sowing); T_4, Spraying of atrazine @0.75 kg/ha as pre-emergence + Spraying of topramezone @25.2 g/ha as post-emergence on 25 DAS; T_5, Spraying of atrazine @0.75 kg/ha as pre emergence + Tembotrione @120 g/ha on 25 DAS; T_6, Spraying of atrazine @1 kg/ha as pre-emergence + Topramezone @25.2 g/ha on 25 DAS; T_7, Spraying of atrazine @1 kg/ha as pre-emergence + Tembotrione @120 g/ha on 25 DAS; T_8, Spraying of topramezone @25.2 g/ha + atrazine @0.75 kg/ha on 15 DAS; and T_9, Spraying of tembotrione @120 g/ha + atrazine @0.75 kg/ha on 15 DAS], replicated thrice. The results evinced that application of topramezone at 25.2 g/ha + atrazine at 0.75 kg/ha on 15th day after sowing significantly reduced the weed density and dry weight leading to higher weed control efficiency and lower weed index of 62.0% and 3.1%, respectively, during both the years of study. This treatment resulted in higher grain yield (7675 kg/ha), net returns (₹72884/ha) and benefit cost (B:C) ratio (2.33) in irrigated maize.

Keywords: Economics, Maize, Tembotrione, Topramezone, Weed parameters, Yield

Maize (*Zea mays* L.) is one of the dominant and promising cereal crops in India next to rice and wheat grown in almost all the states in larger area owing to its wide adaptability. In India, low production potential of maize is attributed to usage of conventional varieties, imbalanced application of organic and inorganic fertilizers, indiscriminate use of herbicides, pesticides and fungicides etc. (Adhikary *et al*. 2020). Among them, weeds offer severe competition for natural resources at early stage of crop growth thus suppressing crop plants leading to yield losses of 35–41% (Muchhadiya *et al*. 2022).

Highly expensive manual weeding and labour scarcity during important field operations warrants the usage of various herbicide molecules to control different weed flora in maize (Ghrasiram *et al*. 2020). Topramezone is a selective new generation herbicide used for managing grassy and broad-leaf weeds in maize. Among the different grassy weeds, itch grass (*Rottboellia cochinchinensis*) is a dominant annual weed in maize ecosystem (Bolfrey-Arku *et al*. 2011) which can grow up to a height of more than 4 m with profuse tillering and thrives well in tropical and subtropical climate with high seed multiplication ratio (Meksawat and Pornprom 2010). The stem has numerous hairs, which makes it difficult for weeding by manual labour. On application, topramezone is retained by leaves and translocated to all the parts of weeds which inhibits hydroxyphenyl pyruvate dioxygenase enzyme leading to depletion of tocopherols and carotenoids (Singh *et al*. 2012) resulting in leaf bleaching and damage to cell membrane. Ultimately, sensitive weeds soon after spraying start drying finally resulting in death (Bollman *et al*. 2008). Various experiments conducted in India revealed that different species of weed flora in maize were not controlled by mere spraying of atrazine alone. New generation herbicides possessing different mechanisms are required to control different types of weeds especially itch grass which is a predominant weed in Tamil Nadu. Hence, an experiment was planned to study the efficacy of new generation herbicide mixtures in irrigated maize.

MATERIALS AND METHODS

The experiment was conducted during rainy (*kharif*) seasons of 2020 and 2021 at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. The texture of soil was sandy clay loam, and with respect to nutrient status, it was low in available nitrogen (246 kg/ha), medium in available

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phosphorus (18.7 kg/ha) and high in available potassium (524 kg/ha) with a *p*H of 8.34. The experiment was laid out in a randomized complete block design (RCBD) comprised of 9 treatments, viz. T_1, Weedy check; T_2, Weed free check; T_3, Spraying of atrazine @1 kg/ha as pre-emergence + Hand weeding on 25 DAS (days after sowing); T_4, Spraying of atrazine @0.75 kg/ha as pre-emergence + Spraying of topramezone @25.2 g/ha as post-emergence on 25 DAS; T_5, Spraying of atrazine @0.75 kg/ha as pre emergence + tembotrione @120 g/ha on 25 DAS; T_6, Spraying of atrazine @1 kg/ha as pre-emergence + topramezone @25.2 g/ha on 25 DAS; T_7, Spraying of atrazine @1 kg/ha as pre-emergence + tembotrione @120 g/ha on 25 DAS; T_8, Spraying of topramezone @25.2 g/ha + atrazine @0.75 kg/ha on 15 DAS; and T_9, Spraying of tembotrione @120 g/ha + atrazine @0.75 kg/ha on 15 DAS, replicated thrice.

Recently released maize hybrid CO 6 was sown during *kharif* season (June–September) in both the study years. After sowing, agro techniques for cultivation of maize were adopted in accordance with package of practices developed by Tamil Nadu Agricultural University. Density of weeds at 50 DAS and at harvest was recorded following quadrat method through random sampling. The weeds were identified based on morphological characteristics, shade dried and oven dried at 80°C till the invariable weight was reached for estimating weed dry matter. Data on weed dry weight and grain yield were utilized for calculating weed control efficiency and weed index (Das 2008).

$$\text{Weed control efficiency} = \frac{\text{Dry weight of weeds in weedy check} - \text{Dry weight of weeds in treatment plot}}{\text{Dry weight of weeds in weedy check}} \times 100$$

$$\text{Weed index} = \frac{\text{Grain yield obtained in weed free plot} - \text{Grain yield obtained in treatment plot}}{\text{Grain yield obtained in weed free plot}} \times 100$$

Yield attributing characters, viz. length and girth of cob, grain rows/cob, grains/row and test weight, grain yield and stover yield were recorded. These recorded observations were statistically analyzed as per Gomez and Gomez (2010) (SPSS v 26.0).

RESULTS AND DISCUSSION

Effect of weed management practices on weed density, weed dry weight on 50 DAS, weed control efficiency and weed index: Experimental fields were infested with all categories of weeds. With respect to grasses, *Rottboellia cochinchinensis, Brachiaria reptans, Chloris barbata, Cynodon dactylon, Dactyloctenium aegyptium, Echinochloa colona, Panicum javanicum* were predominant. *Cyperus*

Table 1 Effect of weed management practices on weed density, weed dry weight, weed control efficiency and weed index in maize

Treatment	Weed density on 50 DAS (numbers/m^2)						Weed dry weight on 50 DAS (g/m^2)						Weed control efficiency (%)	Weed index
	2020			2021			2020			2021				
	G	S	BLW	G	S	BLW	G	S	BLW	G	S	BLW		
T_1	7.33 (53.3)	3.54 (12.0)	8.34 (69.0)	7.65 (58.0)	2.79 (7.3)	2.12 (4.0)	7.47 (55.3)	3.08 (9.0)	5.31 (27.7)	21.58 (465.4)	2.90 (7.9)	2.79 (7.3)	0.0	31.0
T_2	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	100	00.0
T_3	5.67 (31.6)	10.75 (115.0)	2.05 (3.7)	5.55 (30.3)	1.95 (3.3)	0.89 (0.3)	7.97 (63.0)	4.64 (21.0)	2.79 (7.3)	12.93 (166.8)	2.10 (3.9)	1.14 (0.8)	54.1	1.8
T_4	7.33 (53.3)	4.56 (20.3)	0.71 (0)	6.23 (38.3)	1.22 (1.0)	0.71 (0)	8.56 (72.7)	4.77 (22.3)	0.71 (0)	15.88 (251.7)	1.22 (1.0)	0.71 (0.0)	39.3	9.9
T_5	10.65 (113.0)	4.15 (16.7)	0.71 (0)	7.47 (55.3)	0.71 (0)	0.71 (0)	10.75 (115.0)	4.22 (17.3)	0.71 (0)	19.79 (391.1)	0.71 (0.0)	0.71 (0.0)	8.6	15.4
T_6	5.18 (26.3)	8.05 (64.3)	0.71 (0)	5.85 (33.7)	2.55 (6.0)	0.71 (0)	7.20 (51.3)	6.44 (41.0)	0.71 (0)	14.94 (222.7)	2.93 (8.1)	0.71 (0.0)	43.6	14.6
T_7	8.17 (66.3)	2.49 (5.7)	0.71 (0)	7.33 (53.3)	0.89 (0.3)	0.71 (0)	9.19 (84.0)	2.61 (6.3)	0.71 (0)	18.54 (343.2)	0.95 (0.4)	0.71 (0.0)	24.2	13.6
T_8	4.95 (24.0)	6.89 (47.0)	0.71 (0)	5.12 (25.7)	2.55 (6.0)	0.89 (0.3)	4.74 (22.0)	6.10 (36.7)	0.71 (0)	12.29 (150.6)	2.79 (7.3)	1.26 (1.1)	62.0	3.1
T_9	8.23 (67.3)	6.77 (45.3)	1.58 (2.0)	6.91 (47.3)	1.79 (2.7)	0.71 (0)	11.07 (122.0)	3.44 (11.3)	1.67 (2.3)	17.02 (289.1)	1.92 (3.2)	0.71 (0.0)	25.3	18.7
SEd	5.36	3.89	2.27	3.41	1.39	0.69	4.83	1.79	2.21	2.75	1.54	0.73	-	-
CD (P=0.05)	NS	NS	4.8	7.2	NS	1.47	10.2	3.8	4.7	5.8	NS	1.5	-	-

Weed data subjected to square root transformation $\sqrt{(x+0.5)}$. The values in parenthesis are original values. G, Grasses; S, Sedges; and BLW, Broad-leaf weeds; DAS, Days after sowing. Treatment details are given under Materials and Methods.

rotundus was dominant weed among the sedges. Among broad-leaf weeds, *Trianthema portulacastrum, Boerhaavia diffusa, Cleome viscosa, Cynotis axillaris, Digera arvensis, Euphorbia geniculata, Parthenium hysterophorus* and *Portulaca oleracea* were dominant.

The data on weed parameters revealed that weed management practices did not show any remarkable influence on grassy weeds and sedges during 2020 (Table 1). Contrary to 2020, there was a significant influence of treatments on grassy weeds during 2021. Application of topramezone @25.2 g/ha + atrazine @0.75 kg/ha on 15 DAS registered lower density of grasses (5.12 numbers/ m^2).This treatment was comparable with T_3, T_6, T_4 and T_9 (Fig. 1). Combined spraying of topramezone @25.2 g/ ha and @0.75 kg/ha atrazine resulted in lower density of *Rottboellia cochinchinensis* (itch grass) compared to other grasses in both the years. This was ascribed to disruption in carotenoid synthesis due to inhibition of enzyme activity especially HPPD (4-hydroxy phenyl pyruvate dioxygenase) in weeds resulting in leaf bleaching, and death of weeds (Neelam Gupta and Shrikant Chitale 2023). The result confirms the findings of Jadhav *et al*. (2023). Spraying of tembotrione and atrazine was highly effective in controlling grassy weeds except *Rottboellia cochinchinensis* (Fig. 2). It is evident from this study that application of topramezone and atrazine is highly effective where *Rottboellia cochinchinensis* is dominant. Weed management practices did not show any significant influence on sedges in both the years. Application of herbicides and other weed management practices remarkably influenced the density of broad-leaf weeds during 2020 and 2021. It was clearly evident from the data that spraying of topramezone in combination with atrazine and tembotrione in combination with atrazine effectively controlled the broad-leaf weeds during 2020 and 2021. Among them, spraying of atrazine @1 kg/ha as pre-emergence + tembotrione at 120 g/ha on 25 DAS was found to be superior in controlling broad-leaf weeds. This might be due to disruption in biosynthesis of chlorophyll and membrane structure. Yadav *et al*. (2018) also observed the similar reduction in density of broad-leaf weeds on application of herbicides.

Assessment of dry matter production of weeds is an important parameter to measure competition of weeds than density of weeds as it measures the resource utilization by weeds effectively. Weed management practices evinced remarkable influence on dry weight of weeds in both the study years (Table 1). In the year 2020, spraying of topramezone @25.2 g/ha + atrazine @0.75 kg/ha on 15 DAS recorded lower grassy weed dry weight of 4.74 g/m^2. This treatment was on par with T_6, T_1, T_3, T_4 and T_7 but was significantly superior to other treatments. During 2021 also, spraying of topramezone @25.2 g/ha + atrazine @0.75 kg/ha on 15 DAS recorded lower dry weight of grasses (12.29 g/m^2). This was on par with T_3, T_6, T_4 and T_9 but was significantly superior to T_5 and T_1. Lower dry matter in this treatment could be ascribed to higher efficacy coupled with longer persistence of topramezone leading to very low energy level of weeds. Similar observations were recorded by Raut *et al*. (2017). In respect of sedges, pre-emergence application of atrazine @1 kg/ha followed by tembotrione @ 120 g/ha on 25 DAS recorded lower weed dry weight (2.61 g/m^2). This was comparable with T_1, T_9, T_5, T_3, T_4 and T_8 during 2020. Weed management practices did not exert significant influence on dry weight of sedges in 2021. Nevertheless, the lowest dry weight of sedges (0.95 g/m^2) was observed with the pre-emergence application of atrazine @1 kg/ha followed by Tembotrione @120 g/ha on 25 DAS. Spraying of topramezone and tembotrione as post emergence herbicides along with atrazine registered lower dry weight of broad-leaf weeds during 2020 and 2021. This effect could be ascribed to improved absorption and translocation of topramezone and tembotrione by the weeds leading to death of weeds. In addition, these herbicides averted further germination of weeds resulting in lower density of weeds and corresponding dry weight. Earlier similar results were documented by Chaudhari *et al*. (2023).

The highest weed control efficiency (62.0%) was recorded with application of topramezone @25.2 + atrazine @0.75 kg/ha on 15 DAS which clearly evinced the impact of herbicides on weeds and the highest weed index (31.0) was registered under weedy check which revealed that the reduction in grain yield of maize may go up to 31%, if

Fig. 1 Application of topramezone @25.2 g/ ha + atrazine @0.75 kg/ha on 15 DAS (days after sowing) in maize.

Fig. 2 Application of tembotrione @120 g/ ha + atrazine at 0.75 kg/ha on 15 DAS (days after sowing) in maize.

Fig. 3 Weedy check - Infestation of itch grass during grain filling stage in maize.

Table 2 Effect of weed management practices on weed density and weed dry weight at harvest in maize

Treatment	Weed density at harvest (number/m^2)						Weed dry weight at harvest (g/m^2)					
	2020			2021			2020			2021		
	G	S	BLW	G	S	BLW	G	S	BLW	G	S	BLW
T_1	5.64 (31.3)	3.29 (10.3)	1.08 (0.67)	6.18 (37.7)	2.55 (6.0)	2.12 (4.0)	8.29 (68.3)	1.95 (3,3)	1.79 (2.7)	23.28 (541.5)	2.85 (7.6)	2.83 (7.5)
T_2	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)
T_3	5.85 (33.7)	5.08 (25.3)	2.28 (4.7)	6.31 (39.3)	2.05 (3.7)	0.89 (0.3)	5.04 (24.9)	3.63 (12.7)	3.90 (14.7)	23.43 (548.4)	2.21 (4.4)	1.14 (0.8)
T_4	4.98 (24.3)	5.05 (25.0)	1.22 (1.0)	4.82 (22.7)	1.34 (1.3)	0.71 (0)	4.95 (24.0)	3.29 (10.3)	1.48 (1.7)	18.06 (325.8)	1.45 (1.6)	0.71 (0.0)
T_5	5.52 (30.0)	5.90 (34.3)	0.71 (0)	5.50 (29.7)	1.10 (0.7)	0.71 (0)	5.08 (25.3)	3.03 (8.7)	0.71 (0.0)	21.21 (449.2)	1.14 (0.8)	0.71 (0.0)
T_6	3.90 (14.7)	6.07 (36.3)	1.79 (2.7)	4.34 (18.3)	2.12 (4.0)	0.71 (0)	3.55 (12.1)	3.85 (14.3)	1.58 (2.0)	16.48 (271.0)	2.47 (5.6)	0.71 (0.0)
T_7	6.31 (39.3)	4.10 (16.3)	1.87 (3.0)	6.26 (38.7)	1.34 (1.3)	0.71 (0)	5.25 (27.1)	3.97 (15.3)	1.84 (2.9)	23.91 (571.2)	1.38 (1.4)	0.71 (0.0)
T_8	2.55 (6.0)	5.70 (32.0)	1.58 (2.0)	4.22 (17.3)	1.95 (3.3)	0.89 (0.3)	2.72 (6.9)	4.04 (15.8)	1.34 (1.3)	15.94 (253.5)	2.21 (4.4)	1.30 (1.2)
T_9	3.67 (13.0)	4.56 (20.3)	2.19 (4.3)	5.67 (31.7)	1.67 (2.3)	0.71 (0)	3.03 (8.7)	3.97 (15.3)	1.82 (2.8)	21.95 (481.3)	1.87 (3.0)	0.71 (0.0)
SEd	1.51	2.98	0.93	2.61	0.77	0.88	1.13	2.19	0.99	3.25	1.62	1.08
CD (*P*=0.05)	3.2	NS	1.98	5.5	NS	1.87	2.4	NS	2.1	6.9	NS	2.3

Weed data subjected to square root transformation $\sqrt{(x+0.5)}$. The values in parenthesis are original values. G, Grasses; S, Sedges; and BLW, Broad-leaf weeds. Treatment details are given under Materials and Methods.

the weeds are not controlled effectively. The results are in accordance with the findings of Rajan *et al*. (2023).

Effect of weed management practices on weed density and weed dry weight at harvest: Weed management practices exerted significant influence on grassy weed density at harvest during both the years (Table 2). Application of topramezone @25.2 g/ha + atrazine @0.75 kg/ha on 15 DAS registered lower grassy weed density during 2020 and 2021 which was on par with treatment T_9, T_6, T_4 and T_5. This could be attributed to effective control of emerging weeds through application of topramezone along with atrazine that prevented the new flushes of weeds. The results are in accordance with the findings of Kumar and Chawla (2019).The treatments failed to influence the density of sedges at harvest in both the years. During 2020 and 2021, treatments remarkably influenced the density of broad-leaf weeds. Combined application of atrazine either with topramezone or tembotrione controlled the broad-leaf weeds effectively during both the years. The results confirm the findings of Kakade *et al*. (2020) who observed lower dry weight of weeds compared to other herbicides on pre emergence application of atrazine @0.5 kg/ha followed by tembotrione @0.120 kg/ha at 20 DAS.

There was a significant influence of treatments on dry weight of weeds except dry weight of sedges in both the years (Table 2). Spraying of topramezone @25.2 g/ha + atrazine @0.7 5 kg/ha on 15 DAS recorded lower grassy weed dry weight at harvest. This was on par with treatment T_9, T_6, T_4 and T_5 in both the years. Lower dry weight was mainly attributed to prolonged effectiveness of applied herbicide. Similar view has been expressed by Jadhav *et al*. (2023). Dry weight of sedges was not remarkably influenced by treatments at harvest during 2020 as well as 2021.Combined application of topramezone and tembotrione along with atrazine resulted in lower dry weight of broad-leaf weeds during both the years. The results confirm the findings of Rajan *et al*. (2023) who observed drastic reduction in dry weight of broad-leaf weeds on application of these herbicides.

Effect of herbicides and other weed management practices on yield attributes and grain yield of maize: The results of present study revealed that weed management practices did not exert any remarkable influence on yield attributing characters during both the years except cob length (Table 3). Weed free check registered higher cob length and girth, grain rows/cob, grains/cob and test weight during both the years. This might be due to regular and periodic removal of weeds which helped to absorb more nutrients, water and other resources by the plant that favoured the yield attributes (Chauhan *et al*. 2022). Weed free check was closely followed by spraying of topramezone @25.2 g/ha + atrazine @0.75kg/ha on 15 DAS, which recorded

Table 3 Effect of weed management practices on yield attributes, yield and economics of maize

Treatment	Cob length (cm)		Cob girth (cm)		Grain rows/ cob		No.of grains/ row		100-seed weight (g)		Grain yield (kg/ha)		Net returns (₹/ha)		B:C ratio	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T_1	18.0	15.3	14.5	14.1	14.1	13.2	29.8	28.5	35.9	36.8	5375	5538	39113	41726	1.79	1.86
T_2	21.7	18.8	15.3	16.6	14.8	14.3	35.4	34.5	38.6	39.9	7787	8029	70727	74582	2.17	2.25
T_3	21.0	18.7	15.2	16.4	14.8	14.1	34.8	34.4	38.8	39.9	7651	7882	69948	73636	2.20	2.28
T_4	20.7	18.1	14.9	15.9	14.7	13.9	34.2	33.4	36.7	37.8	7442	6791	68504	57970	2.23	2.05
T_5	20.2	17.2	14.8	15.3	14.3	13.6	32.3	29.8	36.5	36.1	7146	6224	63705	48401	2.16	1.89
T_6	19.9	18.2	14.6	16.2	14.3	13.9	33.0	33.7	36.3	38.2	6594	6923	54031	60225	1.98	2.09
T_7	20.5	17.7	14.8	15.6	14.7	13.6	33.9	31.1	36.7	36.4	7274	6367	65963	50999	2.20	1.94
T_8	21.0	18.5	15.0	16.4	14.8	14.1	34.8	34.4	37.4	38.7	7559	7764	70523	74840	2.26	2.38
T_9	19.3	17.8	14.5	15.8	14.1	13.7	32.8	32.1	35.7	36.6	6287	6578	49830	55729	1.92	2.04
CD (P=0.05)	1.67	1.70	NS	1.22	NS	NS	NS	NS	NS	NS	1034	1062	-	-	-	-

Treatment details are given under Materials and Methods.

higher cob length (21.0 and 18.5 cm), cob girth (15.0 and 16.4 cm), grain rows/cob (14.8 and 14.1), grains/ row (34.8 and 34.4) and 100-seed weight (37.4 and 38.7 g) during 2020 and 2021, respectively compared to other treatments. Lesser weed density favoured more assimilation of photosynthates resulting in improved yield attributing characters. Sivamurugan *et al*. (2017) also documented similar results with the application of these herbicides.

Application of different herbicides and other practices influenced the grain yield of maize remarkably during both the years. Among the treatments, weed free check registered higher grain yield of 7787 kg/ha and 8029 kg/ ha during 2020 and 2021, respectively which was on par with treatment T_3, T_8, T_4, T_7, T_5 and T_6 during 2020 and on par with T_3, T_8 and T_6 during 2021.This could be ascribed to enhancement in growth and yield attributes owing to low crop-weed competition thus ensured proper utilization of natural resources. The results corroborate the findings of Chandrabhan (2016) and Divyanshi *et al.* (2022).With regard to herbicides, spraying of topramezone @25.2 g/ha + atrazine @0.75 kg/ha on 15 DAS registered higher grain yield of 7559 and 7764 kg/ha during 2020 and 2021, respectively. This was ascribed to lower density of weeds due to leaf bleaching and death of weeds which in turn favoured more accumulation of photosynthates in the sink leading to improved yield. The results confirm the findings of Rani *et al*. (2022). Lower yield of 5375 and 5538 kg/ha was recorded in weedy check during 2020 and 2021, respectively. This was due to severe crop weed competition for natural resources under uncontrolled condition (Fig. 3). These results are in accordance with the findings of Saimaheswari *et al.* (2022).

Effect of herbicides and other weed management practices on economics of maize: Among the different treatments, weed free check registered higher net return (₹70727/ha and ₹74582/ha) and lower B:C ratio (2.17 and 2.25) during 2020 and 2021, respectively which could be attributed to higher cost incurred in manual weeding .With respect to different herbicides, spraying of topramezone @25.2 g/ha + atrazine @0.75 kg/ha on 15 DAS registered higher net return (₹70523/ha and ₹74840/ha) and B:C ratio (2.26 and 2.38) during 2020 and 2021, respectively. This could be ascribed to less cost of herbicides and high yield realized under this treatment. Weedy check registered lower net returns and B: C ratio during both the years. Similar findings were also reported by Kumar and Chawla (2019) and Jadhav *et al*. (2023).

Based on the results of two years of experimentation, it is concluded that in irrigated maize in sandy clay loam soils, combined application of topramezone at 25.2 g/ha + atrazine at 0.75 kg/ha on 15 DAS as post-emergence herbicides effectively controlled grasses, sedges and broad-leaf weeds apart from realizing higher yield and monetary returns.

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