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Effect of integrated weed management on weed dynamics and yield in maize

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Abstract
A field experiment was carried out during the *kharif* season of 2024 at PG Research Farm, Rajarshee Chhatrapati Shahu Maharaj College of Agriculture, Kolhapur, with ten treatments replicated thrice laid out in Randomized Block Design (RBD) to evaluate the integrated weed management in *kharif* maize (*Zea mays* L.) The results revealed that the weed free check (T_9) recorded higher yield (grain, stover - 72.23, 128.74 q ha^{-1}, respectively), Weed Control Efficiency (99.70%) and lower Weed Index (0.00%) and among the various herbicidal treatments the PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* hand weeding at 40 DAS (T_4), recorded higher yield (grain, stover- 69.27, 122.34 q ha^{-1}, respectively), Weed Control Efficiency (70.42%), lower Weed Index (3.26%) and highest B:C Ratio (2.79), followed by PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* hand weeding at 40 DAS (T_6). The Weedy check treatment (T_{10}) recorded lowest yield (grain, stover - 41.25, 96.98 q ha^{-1}, respectively), Weed Control Efficiency (0.00%) and higher Weed Index (42.39%).

Keywords: Maize, herbicidal, integrated weed management, weed, Mesotrione, atrazine, maize yield.

Introduction
Maize (*Zea mays* L.) is a C_4 plant known for its high yield potential, it has been also named as “Queen of Cereals" and the "Miracle Crop." Weed are a major impediment to crop production through their ability to compete for resources and their impact on product quality. The key period for crop-weed competition in maize during the rainy season is between 15 and 45 days after sowing (DAS), according to Kumar *et al.* (2015) [9]. Therefore, in order to maximize productivity during this window, effective weed management is crucial. It is known that more than 90 weed species seriously reduce maize yields by competing with the crop during the early growth stages (Ariraman *et al.*, 2020) [2]. Because of its extreme susceptibility to weed competition, severe weed infestation has been seen to reduce maize output by as much as 70%. In comparison to manual weed control, the chemical technique is more versatile, less labour-intensive, and more economical (Sutton *et al.*, 2002) [23]. Post-emergence herbicides can avoid interference during harvest and are essential in lowering crop weed competition throughout the vital growth stages. By using these herbicides between 20 and 25 DAS, weeds can be controlled and crop loss from weed competition can be avoided. Several studies have shown that combining several weed management strategies, particularly the use of herbicides and mechanical methods, leads to more efficient weed suppression, is more cost-effective, and improves environmental health. According to Megersa *et al.*, (2018) [15], the maximum grain yield of 58.13 quintals ha^{-1} was obtained by using weed knock at 2 L ha^{-1} and then manually weeding 40 days after sowing (DAS), the results demonstrated statistical comparability to other treatments, and this yield advantage over untreated plots was 33%. Given the increasing challenges of herbicide resistance and the need for environmentally sound crop production, the present investigation was therefore designed to evaluate the efficacy of various integrated weed management strategies and to quantify their impact on weed population shifts and maize yield outcomes under *kharif* condition.

Material and methods

Experimental site

The field experiment was carried out during *Kharif*, 2024 at the PG Research Farm, RCSM College of Agriculture, Kolhapur. The topography of the experimental field was fairly uniform and levelled. The average annual rainfall is 1057 mm, with 84 rainy days, which received 80 per cent from south-west monsoon in June to September, while the remaining quantity is received in the months of October and November from north-east monsoon. The annual mean maximum temperature ranges between 34^0C and 40^0C while, the annual mean minimum temperature varies from 6^0C to 10^0C.

Soil characters: The soil of the experimental plot was sandy clay loam, low in available Nitrogen (292.96 kg ha^{-1}), very high in available phosphorus (35.87 kg ha^{-1}) and high available potassium (328.43 kg ha^{-1}). The status of organic carbon content (0.59%) was high. The electrical conductivity and pH values were 0.42 dSm^{-1} and 7.84 respectively.

Experimental set-up

The experiment was laid out in a Randomized Block Design (RBD) comprising ten treatments, each replicated three times. The treatment details are as follows:

- **T_1:** PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS
- **T_2:** PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS
- **T_3:** PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS
- **T_4:** PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS
- **T_5:** PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS
- **T_6:** PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS
- **T_7:** PoE application of 2,4-D Sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS
- **T_8:** PoE application of 2,4-D sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS
- **T_9:** Weed-free check
- **T_{10}:** Weedy check

The sowing of seeds of variety Rajarshee was done by dibbling two seeds per hill on one side of ridges and furrows opened at 75 cm apart with the help of marker and two seeds were dibbled in row at 20 cm spacing at a depth of 4-5 cm to obtain uniform plant population. The seed rate @ 15 kg ha^{-1} was used. Each gross plot measured 4.0 m × 6.0 m, and the net plot area was maintained at 3.2 m × 3.0 m.

The recommended dose of inorganic fertilizer for this variety of maize (120:60:40 NPK kg ha^{-1}) was applied using urea, single superphosphate, and muriate of potash, respectively. All herbicides were uniformly sprayed using of knapsack with flat-fan nozzle. One hand-weeding was performed 40 days after sowing in various treatments.

Observation to be recorded

Observations on weed density were taken as monocot, dicot and sedges at 20, 40, 60, 80 DAS and at harvest, randomly, from plot area in each treatment with 1.0 m ×1.0 m quadrat and individual weed count summed up to obtain total weed count. The data were presented as number of weeds m^{-2} and data were transformed to square-root transformation before statistical analysis.

The weed samples were collected 20, 40, 60, 80 DAS and at harvest from 1.0 square meter area. These samples were sun dried and then finally dried in the electrical oven at 65° C for 24 hours. Dry weight of monocot, dicots and sedges recorded separately at all observations when samples attained a constant weight. The individual dry weights were summed up to obtain total weed dry weight (g m^{-2}) from that particular treatment. The dry weight was expressed in g m^{-2}. Weed-control efficiency (WCE) and weed-control index (WCI) of maize at harvest were calculated as per the formula suggested by Kondap and Upadhyay, (1985) [8], Gill and Kumar (1969) [7] respectively.

The yield contributing characters *viz*. Number of cobs plant^{-1}, length of cob (cm), diameter of cob (cm), weight of cobs plant^{-1} (g), seed index (g) was recorded on five randomly selected and marked plants, which were already used for the growth studies from each net plot. Grain yield (q ha^{-1}) and stover yield (q ha^{-1}) from each net plot.

The cost of cultivation was calculated on per hectare basis by considering the hire charges of labour and market value of other inputs Gross monetary return (GMR) was computed on per hectare basis from the final cob and fodder yield of *kharif* maize and its prevailing market price offered by Commission for Agricultural Costs and Prices (CACP), Government of India in 2024. Net monetary returns were calculated by deducting the cost of cultivation from gross monetary returns for all the treatment combination. The benefit: cost ratios (B:C) were calculated by the cost of cultivation divided by net monetary returns.

Results and discussion

Weed Flora

The experimental field was infested with a diverse spectrum of weed species, encompassing monocot weeds, dicot weeds and sedges. The monocot weeds are *Cyanodon dactylon*, *Brachiaria reptans*, *Echinochloa crus-galli*, *Dactylactenium aegyptium*, dicot weeds are *Parthenium hysterophorus*, *Euphorbia corollate*, *Amaranthus viridis*, *Amaranthus powellii*, *Commelina benghalensis*, *Ipomoea hederacea* and sedges included *Cyperus rotundus* species. The identical conclusions were confirmed by Barad *et al.*, (2016) [3], Kumawat *et al.*, (2019) [11] and Sharma and Rayamajhi (2022) [21].

Weed count

The data on mean number of monocots, dicot and sedges weed at 20, 40, 60, 80 DAS and at harvest presented was notably lowest in Weed Free Check (T_9- 2.67, 2.00, 2.00, 1.67, 2.00 respectively) treatment and highest in Weedy Check (T_{10}- 54.00, 67.67, 89.00, 102.00, 115.67 respectively) treatment. Among the different integrated weed management treatments lowest total weed count was recorded in PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_4- 39.33, 2.33, 16.00, 35.33, 50.33 respectively) followed by PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_6- 43.67, 3.00, 17.67, 39.33, 54.00, respectively) throughtout the observational stages, this could be because the combination of treatment with two different biochemical modes of action reduced weed count effectively. The identical conclusions were validated by

Abdullah *et al.*, (2016) [1], Mandi *et al.*, (2019) [13] and Bhattarai *et al.*, (2022) [4].

Weed Dry Matter

The data on mean dry matter of monocot, dicot and sedges weed at 20, 40, 60, 80 DAS and at harvest presented in Table.1. was notably lowest in Weed Free Check (T_9- 1.01, 0.75, 0.73, 0.59, 0.63 g, respectively) treatment and highest in Weedy Check (T_{10}-25.36, 64.60, 113.59, 162.95, 214.67 g, respectively) treatment. Among the different integrated weed management treatments, the lowest mean total dry matter was recorded in PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_4- 8.71,1.38, 12.64, 41.12, 63.50 g respectively), throughout the observational stages followed by PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_6- 20.54,1.83 14.11 46.54, 68.97 g respectively). This primarily due to the complementary and integrated effect if theses two methods, this dual approach interrupts weed growth at multiple stages, significantly reducing weed biomass accumulation. The similar results were affirmed by Mathukia *et al.*, (2014) [14], Samanth *et al.*, (2015) [20] and Deewan *et al.*, (2018) [6].

Weed Control Efficiency (WCE)

The data of weed control efficiency presented in Table 2 revealed that the weed control efficiency (%) at harvest affected by different integrated weed management treatments significantly, the highest weed control efficiency in Weed Free Check (T_9-99.70%) treatment and lowest in Weedy Check (T_{10}-0.00%) treatment, among the various integrated weed control treatments, the highest weed control efficiency recorded in treatment PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_4- 70.42%) followed by PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_6- 67.87%). This might be due to only herbicides provide initial broad control, but herbicides followed by hand weeding meticulously removes survivors, resistant weeds, and later-emerging flushes missed by chemicals. This combined approach combats herbicide resistance, ensures a cleaner field for longer, and optimizes overall weed management in the field. The corresponding results were demonstrated by Mandi *et al.*, (2019) [13] and Chauhan *et al.*, (2022) [5].

Weed Index (WI)

The Table 2 displaying weed index data at harvest clearly indicate a significant impact of various integrated weed management treatments. The highest weed index in Weed Free Check (T_9-0.00%) treatment and lowest in Weedy Check (T_{10}-42.39%) treatment, among the various integrated weed control treatments, the lowest weed index was recorded in PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_4- 3.26%) followed by PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_6- 8.59%) This is because of IWM employs a multifaceted and synergistic approach to weed control, rather than relying on a single method. The combination of tactics leads to more comprehensive and sustained suppression of weed populations, resulting in less competition with the crop and, consequently, higher yields. The similar findings were confirmed by Mandi *et al.*, (2019) [13] and Chauhan *et al.*, (2022) [5].

Yield and Yield attributing characters

The data regarding yield attributing characters, under the impact of different integrated weed management treatments are showed in Table 3. among various integrated weed management treatments the higher yield and yield attributing chararacters *viz.*, number of cobs plant^{-1}(1.80), length of cob (20.57cm), diameter of cob (5.55 cm), weight of cobs (970 g), seed index (100 seeds) (28.19g), grain yield (72.23 q ha^{-1}) and stover yield (128.74 q ha^{-1}) noted in the Weed Free Check (T_9) treatment and it was on par with PoE application of mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_4) recorded highest yield and yield attributing chararacters *viz.*, number of cobs plant^{-1}(1.60), length of cob (20.19 cm), diameter of cob (5.22 cm), weight of cobs (951.67 g), seed index (100 seeds) (26.60 g), grain yield (69.27 q ha^{-1}) and stover yield (122.34 q ha^{-1}) followed by PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_6) recorded highest yield and yield attributing chararacters *viz.*, number of cobs plant^{-1}(1.47), length of cob (18.81cm), diameter of cob (4.90 cm), weight of cobs (866.67 g), seed index (100 seeds) (25.26 g), grain yield (65.45q ha^{-1}) and stover yield (116.59 q ha^{-1}). This might be due to integrated weed management in maize that helps to reduce competition for vital resources and promote maize plants can fully utilize these resources, boosting photosynthetic efficiency and overall plant vigor. Results confirmed with those Rasool and Khan (2016) [18], Suseendran *et al.*, (2019) [22], Chauhan *et al.*, (2022) [5], Nimanwad *et al.*, (2022) [17], Kumari (2024) [10] and Maheswaran *et al.*, (2024) [12].

Economics

The evaluation of individual treatments by using market price of maize ton^{-1}, the data showed in Table 4 that the treatment Weed Free Check (T_9) treatment recorded maximum gross monetary return, net monetary return, cost of cultivation and the lowest net monitory return was recorded in Weedy Check (T_{10}) treatment. Among the different integrated weed management treatment PoE application of mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_4) recorded highest gross monetary return (178484), net monetary return (114548), B:C ratio (2.79) followed by PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS (T_6- 65.45 q ha^{-1}) recorded highest gross monetary return (168743), net monetary return (61153), B:C ratio (2.76) due to effectively controlling weeds, improving yield and nutrient use efficiency. It balances higher grain production with optimized input costs, resulting in superior profitability through enhanced crop growth, reduced weed competition, and cost-effective management. Similar results were reported by Samanth *et al.*, (2015) [20], Naik and Tham. (2018) [16] and Ratre and Ratre (2018) [19].

Table 1: Effect of integrated weed management treatments on mean weed count and dry matter of total weeds in maize

Treatment		Mean total weed count (No.m^{-2})					Mean total dry matter of weeds (g m^{-2})				
		20 DAS	40 DAS	60 DAS	80 DAS	At Harvest	20 DAS	40 DAS	60 DAS	80 DAS	At Harvest
T_1	PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS	46.00 (6.82)	27.67 (5.31)	41.00 (6.44)	56.33 (7.54)	73.00 (8.57)	21.45 (4.68)	27.63 (5.30)	54.56 (7.41)	86.24 (9.31)	133.38 (11.57)
T_2	PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	45.33 (6.77)	4.00 (2.11)	23.00 (4.84)	46.67 (6.87)	61.67 (7.88)	20.35 (4.57)	2.55 (1.74)	19.65 (4.48)	55.32 (7.47)	82.01 (9.08)
T_3	PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS	39.33 (6.29)	18.00 (4.30)	34.00 (5.87)	51.67 (7.22)	69.00 (8.33)	17.71 (4.26)	16.35 (4.10)	42.81 (6.58)	76.14 (8.74)	119.75 (10.96)
T_4	PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	40.00 (6.36)	2.33 (1.57)	16.00 (4.06)	35.33 (5.99)	50.33 (7.13)	8.71 (4.38)	1.38 (1.30)	12.64 (3.62)	41.12 (6.45)	63.50 (8.00)
T_5	PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS	45.00 (6.74)	21.00 (4.63)	34.00 (5.87)	52.67 (7.29)	70.67 (8.44)	20.16 (4.54)	19.41 (4.46)	44.59 (6.71)	78.52 (8.89)	125.53 (11.23)
T_6	PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	43.67 (6.64)	3.00 (1.87)	17.67 (4.26)	39.33 (6.31)	54.00 (7.38)	20.54 (4.59)	1.83 (1.52)	14.11 (3.82)	46.54 (6.86)	68.97 (8.33)
T_7	PoE application of 2,4-D Sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS	45.33 (6.77)	22.33 (4.77)	36.33 (6.07)	54.33 (7.40)	71.67 (8.49)	20.41 (4.57)	21.28 (4.66)	47.56 (6.93)	81.23 (9.04)	128.44 (11.34)
T_8	PoE application of 2,4-D sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	45.33 (6.77)	3.33 (1.94)	19.33 (4.44)	41.33 (6.47)	58.00 (7.65)	20.94 (4.63)	2.03 (1.56)	15.66 (4.00)	48.77 (7.02)	75.27 (8.70)
T_9	Weed free check	2.67 (1.77)	2.00 (1.56)	2.00 (1.56)	1.67 (1.39)	2.00 (1.56)	1.01 (1.22)	0.75 (1.11)	0.73 (1.09)	0.59 (1.02)	0.63 (1.06)
T_{10}	Weedy check	54.00 (7.38)	67.67 (8.25)	89.00 (9.46)	102.00 (10.12)	115.67 (10.78)	25.36 (5.08)	64.60 (8.07)	113.69 (10.68)	162.95 (12.78)	214.67 (14.67)
S.Em±		1.55	0.97	1.64	1.28	1.34	0.67	0.95	1.97	2.87	3.28
CD @ 5%		6.63	2.89	4.88	3.81	4.00	2.00	2.84	5.86	6.14	9.76
General mean		40.66	17.13	31.23	52	62.6	18.66	15.78	36.59	67.74	101.21

Table 2: Effect of weed management treatments on mean weed control efficiency and mean weed index in maize

Treatment		Mean Weed Control Efficiency (%)	Mean Weed Index (%)
T_1	PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS	37.86	19.79
T_2	PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	61.79	9.97
T_3	PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS	44.23	17.08
T_4	PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	70.42	3.26
T_5	PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS	41.52	17.97
T_6	PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	67.87	8.59
T_7	PoE application of 2,4-D Sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS	40.18	18.97
T_8	PoE application of 2,4-D sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	64.93	8.93
T_9	Weed free check	99.70	0.00
T_{10}	Weedy check	0.00	42.39
S.Em±		1.51	2.45
CD @ 5%		4.51	7.30
General mean		52.85	14.69

Table 3: Effect of weed management treatments on yield and yield attributes.

Treatment		Mean number of cobs plant^{-1}	Mean length of cob (cm)	Mean diameter of cob (cm)	Mean weight of cobs plant^{-1} (g)	Mean seed index(g)	Mean grain yield (q ha^{-1})	Mean stover yield (q ha^{-1})
T_1	PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS	1.20	14.97	4.40	716.67	22.46	57.47	110.03
T_2	PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	1.33	18.70	4.80	833.33	24.92	64.44	113.66
T_3	PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS	1.27	16.69	4.68	818.33	23.61	59.34	112.12
T_4	PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	1.60	20.19	5.22	951.67	26.60	69.27	122.34

T_5	PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS	1.20	16.56	4.57	801.67	23.30	58.68	111.19
T_6	PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	1.47	18.81	4.90	866.67	25.26	65.45	116.59
T_7	PoE application of 2,4-D Sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS	1.20	15.20	4.49	796.67	22.87	57.99	110.32
T_8	PoE application of 2,4-D sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	1.40	18.75	4.83	853.33	25.12	65.21	115.45
T_9	Weed free check	1.80	20.57	5.55	970.00	28.19	72.23	128.74
T_{10}	Weedy check	0.93	12.54	3.77	611.67	20.17	41.25	96.98
S.Em±		0.07	0.56	0.17	30.23	0.74	1.85	3.39
CD @ 5%		0.23	1.67	0.53	89.83	2.21	5.53	10.09
General mean		1.34	17.29	14.94	822	24.24	61.13	113.74

Table 4: Effect of weed management treatments on economics of maize

Treatment		Gross Monetary Return (₹ ha^{-1})	Cost of Cultivation (₹ ha^{-1})	Net Monetary Return (₹ ha^{-1})	B:C Ratio
T_1	PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS	148920	56720	92200	2.63
T_2	PoE application of Tembotrione (42% SC) @ 286 g a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	166033	60680	105354	2.74
T_3	PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS	153628	59976	93653	2.56
T_4	PoE application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	178484	63936	114548	2.79
T_5	PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS	151952	57853	94099	2.63
T_6	PoE application of 2,4-D Dimethyl amine salt (58% EC) @ 0.5 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	168743	61153	107590	2.76
T_7	PoE application of 2,4-D Sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS	150198	59481	90718	2.53
T_8	PoE application of 2,4-D sodium salt (440 WG) + Metribuzine (350 WG) + Pyrazosulfuron Ethyl (10 WG) (ready mix) @ 3 kg a.i. ha^{-1} at 15-20 DAS *fb* Hand weeding at 40 DAS	168045	63441	104604	2.65
T_9	Weed free check	186224	70866	115359	2.63
T_{10}	Weedy check	108698	55026	53673	1.98
General mean		159112	61379	97733	2.58

Conclusions

A post-emergence application of Mesotrione (2.27% SC) + Atrazine (22.7% SC) (ready mix) @ 3.5 kg a.i. ha^{-1} at 15-20 DAS *fb* hand weeding at 40 DAS, achieved the highest weed control efficiency and the lowest weed index, successfully reduced all types of weeds in the *kharif* maize crop, maximum growth, yield attributes, and overall yield in maize found economical for *kharif* maize, which yielded the highest net returns and Benefit-Cost (B:C) ratio.

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