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COMPARATIVE STUDY ON THE EFFICACY OF PRE AND POST EMERGENT HERBICIDES IN ENHANCING GROWTH AND YIELD OF RAINFED MAIZE (*ZEA MAYS* L.)

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ABSTRACT

A field experiment was carried out at KVK, Reasi, Farm, Reasi during *Kharif* 2022-23 to study the efficacy of pre and post emergent herbicides for weed management in maize (*Zea mays* L.). The experiment was laid out in Randomized Complete Block Design (RCBD) with eight treatments and replicated thrice. The treatments comprised of sole and combined application of pre-emergence herbicides (atrazine) at 3 days after sowing and post emergence herbicides (topramezone and tembotrione) at 3-4 weed leaf stages were compared with two hand weedings (at 20 and 40 DAS), weed free check and unweeded check. Among chemical weed management practices, application of atrazine (50% WP) @ 1 kg a.i. ha^{-1} as pre-emergence at 3 DAS followed by topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as post emergence application at 3-4 weed leaf stages recorded significantly lower total weed density (2.61, 2.34 and 4.26 no. 0.25 m-2 at 20, 40 DAS and at harvest, respectively) and lower total weed dry weight (0.90, 1.31 and 1.49 g. 0.25 m-2 at 20, 40 DAS and at harvest, respectively) with weed control efficiency of 70.4 per cent and weed index of 1.5 per cent at harvest. The same treatment recorded higher kernel yield (11469 kg ha^{-1}), stover yield (13542 kg ha^{-1}), net monetary returns (Rs.130072 ha^{-1}) and B:C ratio (2.43). Hence, it was found to be suitable and economical for effective control of weeds in maize.

Keywords **:** Pre and post emergent herbicides, Chemical weed management, Weed density and weed dry weight

Introduction

Maize (*Zea mays* L.) is the third most important cereal crop in the world, both by area and production after rice and wheat. . In comparison to other important grains including rice (3.7 tons ha^{-1}), wheat (2.5 tons ha^{-1}), and millets (1.2 tons ha^{-1}), it yields an average kernel of 4.1 tons ha^{-1} (Panda, 2010). Furthermore, it supplies around 30% of the calories needed by over 4.5 billion people and is a staple diet for the impoverished in the majority of developing nations. It is widely grown across the world in an area of around 201 m-ha, producing 1162 mt and with a productivity of 5.75 t ha^{-1} (Anonymous, 2020). In terms of area and output, the United States of America leads the world, followed by China. India, on the other hand, is ranked fourth, having grown on 9.89 million hectares of land and seventh in terms of production (31.64 million tons), with an average productivity of 3.20 t ha^{-1}

(Anonymous, 2021). The requirement for maize in the developing countries alone will rise from 282 million tons in 1995 to 504 million tons in 2020, surpassing the demand for both wheat and rice (Baba and Mir, 2018). By 2025, the demand for maize in Asia is predicted to increase from 138 million tonnes in 1993 to 273 million tonnes, or 63% of the increase in world consumption (Baba and Mir, 2018). Jammu region is home of maize cultivation, covering 190,160 thousand hectares and producing 436.523 thousand MT. (Agriculture Directorate, 2018). It is the main crop cultivated in the hilly regions of J&K Nearly every district in the Jammu area grows maize. In terms of output, Rajouri (137.275 thousand MT) and Udhampur (71.068 thousand MT) have the highest concentration of maize. districts of Reasi (39.6 thousand MT) and Poonch (67.577 thousand MT) (Directorate of Agriculture, 2018)

The growth and development of the maize crop is hampered by a variety of factors, despite the fact that new, better varieties and hybrids have enhanced kernel production. One of them is weed infestation. Because of its initial sluggish growth, greater spacing, and increased fertilizer application, maize is quite susceptible to weed competition. The first two to six weeks following seeding are the most crucial for weed competition. Depending on the severity and persistence of weed density in the standing crop, the amount of loss in maize kernel production has been found to range from 33 to 50% (Sharma *et al*., 2000). Therefore, weed control is a crucial procedure to guarantee the best possible kernel yield of maize.

During the critical period, management of weeds is more crucial to achieving a higher yield. Even though hand weeding is an efficient strategy for farmers but it is costly and requires a lot of labor during peak times, and its scarcity makes the use of herbicides necessary to reduce weeds in the early stages of crop growth. In India, there aren't many choices available for managing weeds while using herbicides. Herbicides such atrazine, simazine, pendimethalin, alachlor, and post-emergence usage of 2, 4-D are being utilized to control weeds in maize. According to Patel *et al*. (2006), the majority of these herbicides only provide a limited range of weed management options for maize. However, in this case, herbicides are a major part of the weed management strategy. Atrazine is the most widely used and efficient pre-emergence herbicide for maize, yet it is ineffective against broad-leaved weeds. Hence, it is necessary to evaluate the sequential use of pre- and post-emergence herbicides in order to control this composite and aggressive weed flora throughout later phases of crop growth.

Material and Methods

The field experiment was conducted at KVK, Farm, Reasi, J&K during 2022-23. The site was coming under the region Zone 1– Estern Himalayan. It is situated between N320 58.902 E 74-54.69 with elevation of 2591m above mean sea level. The average rainfall of the zone is 360 mm. In general, soils of the area under study were sandy loam to clay loam in texture with average pH 7.7, medium available organic carbon 0.58 to 0.65 and low in soluble salts (0.16 dSm^{-1}), P2O5 (39.91 kg ha^{-1}), K_2O (202.57 kg ha^{-1}) and medium in available nitrogen (337.52 kg ha^{-1}). The field experiment was laid out with eight treatments and replicated thrice in Randomized Complete Block Design (RCBD). The treatments viz., T1 : Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE application at 3 DAS, T2 : Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE application at 3-4 leaf stages, T3 : Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE application at 3-4 leaf stages, T4 : Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE T5 : Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE, T6 : Handweeding at 20 DAS and 40 DAS, T7 :, Weed Free, T8 : Unweeded check The recommended package of practices was followed for the establishment of crops. The manual hand weeding was done twice at 20 and 40 DAS in the respective treatment of hand weeding. Chemical weed management was carried out with pre and post emergence herbicides as per the treatments. The inter-cultivation was carried out @ 45 DAS which is common for all treatments. Weed free check was maintained in weed free condition upto 60 DAS. At the time of 30 DAS and at harvesting plant height and dry matter production were recorded by keeping in thermo statically controlled oven at 65 + 5°C temperature and dried till it attains constant dry weight. The species wise weed count was taken randomly at two points in each plot in 0.25 m^2 area at different crop growth stages and average was done and classified into grasses, sedges and broad-leaved weeds.

Results and Discussion

Growth Parameters

The data on the growth parameters like plant height, leaf area and dry matter accumulation in maize as influenced by chemical weed management are presented in the Table 1.

Plant Height (cm)

At Harvest weed free check showed noticeably taller plants (196.9 cm). The results of other chemical weed management treatments showed that atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE, topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE, and atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE (193.1 cm) recorded significantly higher plant height (195.2 cm), which was comparable to the results of atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE and T5: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE followed T3: Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE (169.3 cm) and superior to the other treatments (150.1 cm to 180.3 cm). T8: Unweeded Check reportd significantly shortest plants height (150.1) as shown in Table 1. This is because of less weeds infestation and their dry weight during the early phases of crop growth, which increased the availability of essential nutrients which led to more plant growth. The findings agree with those of Arun kumar *et al.* (2020).

Table 1 : Plant height, leaf area and dry matter accumulation of maize as influenced by chemical weed management practices at harvest

Treatment	Plant height (cm)	Leaf area (cm^2 plant^{-1})	Dry matter accumulation (g plant^{-1})
T1:Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE application at 3 DAS	172.3	3356.05	266.32
T2: Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE application at 3-4 leaf stages	174.0	3754.71	263.64
T3: Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE application at 3-4 leaf stages	169.3	3664.23	274.21
T4: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE	195.2	4612.71	319.82
T5: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE	193.1	4444.30	316.42
T6: Handweeding at 20 DAS and 40 DAS	180.3	4388.79	310.69
T7: Weed free check	196.9	4890.10	320.75
T8: Unweeded check	150.1	2827.03	233.17
S.Em ±	8.05	253.20	14.76
CD (p = 0.05)	23.40	736.03	42.90

Leaf Area (cm^2 plant^{-1})

At harvest also, atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE reported significantly highest leaf area (4612.71 cm^2 plant^{-1}) followed by Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE (4444.30 cm^2 plant^{-1}). This was comparable to all other herbicide combinations (4388.79 to 3664.23 cm^2 plant^{-1}), and significantly better than applying a single herbicide alone (3356.05 to 3754.57 cm^2 plant^{-1}). As shown in Table 1, weed free check recorded a much larger leaf area (4890.10 cm^2 plant^{-1}) than any other treatment. This is because early-stage weed management throughout the growth of the maize crop was successful in reducing weed competition, which in turn led to a noticeable increase in leaf area per plant. The similar results were also observed by Khan *et al.* (2002) and Akhtar *et al.* (1984).

Dry Matter Accumulation in Plant (g plant^{-1})

Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as the PE treatment fb topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as the PoE treatment T5: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE respectively, produced significantly higher dry matter production (319.82 and 316.42 g plant^{-1}). This was comparable to T1:Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE and T6: Handweeding at 20 DAS and 40 DAS (274.21 to 310.69 g plant^{-1}), and significantly better than applying a single herbicide alone (266.32 to 263.64 g plant^{-1}). Table 1 shows that weed free check produced much more dry matter (313.8 g plant^{-1}) than any other treatment. The increased production of dry matter is due to better weed management, which would increase leaf area and improve photosynthesis. These results are in conformity with Shinde *et al.* (2001).

Weed Density (No. 0.25 m^{-2})

At 20, 40 DAS and at Harvest Sedge, grass, broad leaf and total weed density recorded at 20, 40 DAS and at harvest were significantly influenced by chemical weed management practices (Table 2).

Table 2 : Weed density (No. 0.25 m^{-2}) as influenced by chemical weed management in maize recorded at 20, 40 DAS and at harvest

Treatment	Total weed density		
	20 DAS	**40 DAS**	**At Harvest**
T1:Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE application at 3 DAS	2.79 (7.33)	6.27 (39.00)	7.23 (52.00)
T2: Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE application at 3-4 leaf stages	5.18 (26.33)	5.42 (29.00)	6.83 (46.33)
T3: Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE application at 3-4 leaf stages	5.33 (28.00)	5.90 (34.33)	6.26 (39.00)
T4: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE	2.61 (6.33)	2.34 (5.00)	4.26 (17.67)
T5: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE	2.86 (8.00)	2.89 (8.33)	4.55 (20.33)
T6: Handweeding at 20 DAS and 40 DAS	3.39 (11.00)	5.18 (26.67)	5.10 (25.67)
T7: Weed free check	3.12 (9.33)	2.04 (4.00)	3.91 (15.00)
T8: Unweeded check	5.37 (28.33)	10.27 (105.0)	9.26 (87.33)
S.Em ±	0.20	0.29	0.33
CD (p = 0.05)	0.59	0.83	0.96

* Square root (X + 0.5) transformed values. Values in the parenthesis are original values. fb - followed by.

At 20 DAS, Weed free check revealed a noticeably reduced overall weed population (3.12 no. 0.25 m^{-2}). Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE were the two chemical applied at different times as weed management treatments showed significantly lower overall weed density (2.61 No. 0.25 m^{-2}) than all other treatments.

Weed free check revealed a noticeably reduced overall weed population (2.04 No. 0.25 m^{-2}) at 40 DAS. followed by Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE (2.34 No. 0.25 m^{-2}), Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE recorded significantly lower total weed density (2.34 No. 0.25 m^{-2}) compared to all other treatments (5.18,5.42,5.90 and 6.27 No. 0.25 m^{-2}). Unweeded check recorded significantly higher sedges, broad leaf, grass and total weed density (10.27 No. 0.25 m^{-2}). Significantly lower total weed population (3.91 No. 0.25 m^{-2}) was recorded in the weed-free check at harvest. whereas almost same trend has been observed in other treatments regarding total weed density (4.26 No. 0.25 m^{-2}). The reason for the reduced density of weeds in the in all the weed management treatments involving single and double use of atrazine topromezone, as well as tembotrione and mechanical weeding had better and longer-lasting effects because they inhibited 4-Hydroxyphenylpyruvate dioxygenase in the early and middle stages, which reduced weed growth, quickly broke down the weeds' ability to synthesise carbohydrates, bleached the white chlorophyll pigment, reduced leaf area, and reduced photosynthesis. Similar findings were also observed earlier by Sanodiya *et al*. (2013), Walia *et al*. (2007), Patel *et al*. (2006), Deshmukh *et al*. (2009), Madhavi *et al*. (2014), Harish *et al*. (2022) and Ramachandra Prasad *et al*. (1990) reported that important weeds observed in maize field were *Cynodondactylon, Digitaria marginata,*

Dactyloctenium aegyptium, Eragrostis pilosa, Eragrostis riparia and *Panicum spp. (*among grasses*), Cyperus rotundus (sedge), Ageratum conyzoides, Amaranthus viridis, Acanthospermum hispidum, Mimosa pudica, Phyllanthus niruri, Portulaca oleracea and Cleome monophylla* (among broad leaved weeds).

Yield Parameters and Yield of Maize

The yield attributing characters of maize varied due to chemical weed management practices are presented in Table 3.

Table 3 : Influence of chemical weed management on attributing characters of maize

Treatment	Yield attributing characters				
	Cob length (cm)	Cob girth (cm)	Cob weight (g)	Kernel weight (g cob^{-1})	Kernel yield (kg ha^{-1})
T1:Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE application at 3 DAS	16.92	16.44	280.89	226.78	8668
T2: Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE application at 3-4 leaf stages	16.77	16.51	286.11	196.78	9570
T3: Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE application at 3-4 leaf stages	17.31	16.61	299.67	211.44	9199
T4: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE	18.86	17.28	331.67	249.66	11469
T5: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE	18.79	17.08	329.33	237.44	11446
T6: Handweeding at 20 DAS and 40 DAS	18.27	17.14	323.67	213.89	10292
T7: Weed free check	18.91	17.30	347.89	230.44	11649
T8: Unweeded check	15.31	14.16	213.00	188.66	6156
S.Em ±	0.78	0.39	23.22	15.58	835.6
CD (p = 0.05)	2.27	1.14	67.49	45.30	2428.9

Cob Length (cm)

The cob length (18.91cm) was substantially higher in the weed-free check. The length of the cob was significantly influenced by chemical weed control treatments. With the application of atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE and topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE, the significantly longer cob length (18.86 cm) was observed. This was statistically comparable to the other treatments (16.77 cm to 18.79 cm), with the exception of unweeded check where cob length of 15.31 cm was observed.

Cob Girth (cm)

Herbicidal treatments reported significant difference in the Cob girth. The results showed a significantly greater cob girth (17.28 cm) with Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE and statistically comparable results with Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as (16.38 cm to 17.14 cm).The cob girth of the unweeded check was substantially less, measuring 14.16 cm. Whereas weed free check observed statistically greatest cob girth (17.30).

Cob Weight (g)

The weight of the cob was significantly impacted by the chemical weed control. A substantially higher cob weight (331.67 cm) was obtained by applying atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE, followed by topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE. This result was statistically comparable to the other treatments (264.22 g to 329.33 g). The length of the cob decreased considerably (213.00 g) with the unweeded inspection.

Kernel Weight Per Cob (g cob^{-1})

Kernel Yield (kg ha^{-1})

Weed free check recorded significantly higher kernel yield (11649 kg ha^{-1}). Among chemical weed management practices, atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE has recorded significantly higher kernal yield (11469 kg ha^{-1}) which was on par with Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE (11446 kg ha^{-1}). However, weed free check produced significantly bhighest kernel yield (kg ha^{-1}) as compared to Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE application at 3 DAS. Application of both Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE application at 3-4 leaf stages and Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE application at 3-4 leaf stages reported statically lower Kernel Yield but significantly at par with the weed free check.

The better return kept in the current examination with atrazine (half WP) @ 1 kg a.i. ha^{-1} as PE followed by topramezone (33.6% SC) @ 50 g a.i. as PoE (8994 kg ha^{-1}) was due to increased growth and yield parameters (Table 1) and (Table 3). Because of the use of both pre- and post-emergent herbicides in maize it has showed most extreme use of nutrients, water, light, and space in the beginning of crop growth which had impacted the development growth and yield components. The total dry matter production in maize at harvest showed significant correlation with

productivity (Table 3). The improvement in yield components was in turn due to improved growth attributes such as higher total dry matter production, leaf area index, better nutrient uptake by crop as quoted by Sreenivas and Satyanarayana (1994), Saini and Angiras (1998), Kamble *et al*. (2005) and Patel *et al*. (2006) and also due to greater availability of nutrients under lower weed competition, which might have promoted higher production and better translocation and partitioning of photosynthates from source to sink. Similar results were also reported by Ahmed and Susheela (2012), Dharmendra *et al*. (2017), Sivamurugan *et al*. (2017) and Hargilas (2017).

Table 4 : Economics of maize cultivation as influenced by chemical weed management

Treatment	Economics of maize cultivation			
	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T1:Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE application at 3 DAS	51194	138688	87494	1.71
T2: Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE application at 3-4 leaf stages	52792	153120	100328	1.90
T3: Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE application at 3-4 leaf stages	52806	147184	94378	1.79
T4: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE	53432	183504	130072	2.43
T5: Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE fb Tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE	55446	183136	127690	2.30
T6: Handweeding at 20 DAS and 40 DAS	51114	164672	113558	2.22
T7: Weed free check	59514	186384	126870	2.13
T8: Unweeded check	48994	98496	49502	1.01

Economics

Atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE recorded higher gross and net returns (183504 and 130072 Rs.ha^{-1}, respectively) among the weed control treatments followed by atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE gross returns (183504 Rs. ha^{-1}) as compared to the rest (98496 Rs ha^{-1} to 183136 Rs ha^{-1}) and lowest was found in unweeded check (98496 and 49502Rs. ha^{-1}). The higher gross and net returns with pre and post emergence application of atrazine and topramezone res pectively was recorded due to better control of weeds which when resulted in higher gowth and yield parameters inturn increases the kernel yield apart from lower cost of cultivation. The results obtained are in accordance with Pandey *et al*. (2002) and Sanjay *et al*. (2012). Among weed control treatments, atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as PoE recorded higher B:C ratio (2.43), followed by atrazine (50% WP) @ 1 kg a.i. ha^{-1} as PE followed by tembotrione (34.4% SC) @ 150 g a.i. ha^{-1} as PoE (2.30) as compared to the rest of the treatments (2.13 to 1.71) and lower B: C ratio (1.01) was noticed in unweeded check. The treatments having combination of pre and post emergence herbicides and treatments having application of only post emergence herbicides recorded significantly higher B:C ratio and the reason might be due higher economic yield, gross returns, net returns and lower cost of cultivation. Based on the results it can be inferred that, sequential application of atrazine (50% WP) @ 1 kg a.i. ha^{-1} as pre-emergence at 3 DAS followed by topramezone (33.6% SC) @ 50 g a.i. ha^{-1} as post emergence application at 3-4 weed leaf stages found suitable and economical for effective control of weeds in maize which recorded higher plant height (195.2 cm), higher leaf area (4612.71 cm^2 plant^{-1}), higher dry matter production (319.8 g plant^{-1}), higher kernel yield (11469 kg ha^{-1}), net monetary returns (130072 Rs. ha^{-1}) and B:C ratio (2.43).

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