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BIO-EFFICACY OF POST-EMERGENT HERBICIDES IN MAIZE UNDER TEMPERATE CONDITIONS OF KASHMIR VALLEY INDIA

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ABSTRACT

A research trial was conducted during *kharif* season 2023 at the Agronomy Research Farm, Division of Agronomy, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadura, India to study the bio-efficacy of post-emergent herbicides on growth, yield and weed control performances in maize. The different herbicides were applied at 30 DAS and were compared under randomized complete block design. The growth and yield parameters were significantly higher with application of tembotrione 120 g/ha with tembotrione 120 g/ha, tembotrione 90 g/ha, halosulfuron 80 g/ha, halosulfuron 60 g/ha, topramezone 40 g/ha and topramezone 30 g/ha which was at par to weed free and application of tembotrione 120 g/ha notably reduced weed dry matter. Maximum benefit: cost ratio (2.59) was worked out with tembotrione 120 g/ha next to weed free. The grain yield of maize was decreased up to 54.01 % due to higher weed infestation in weedy check plots. The maximum weed control efficiency and weed control index was observed under tembotrione 120 g/ha. The results indicate that tembotrione 120 g/ha as post-emergent herbicide applied at 30 days after sowing was found efficient in achieving economically higher grain yield and weed control of maize.
***Keywords* :** Maize, Growth, Herbicide, Weed dynamics, Economics

Introduction

Maize (*Zea mays* L.) or corn is globe's one of the most common cereal grains surmised to have originated from Mexico and Central America about 8700 years ago. Belonging to the family Poaceae, it is the principal food crop in several of the countries all over the world. Having the highest genetic yield potential and nutritive value, it is quite commonly known as "Queen of Cereals"(Sharma, N. & Rayamajhi, M. 2022). Compared to wheat and rice, maize is a relatively more versatile multi-purpose crop (Erenstein, *et al*. 2022). Globally, is cultivated in an area of 193.7 million ha with a production of 1147.7 million metric tonnes and productivity of 5.75 t/ha (FAO, 2020). The USA is the largest producer of maize contributing nearly 36 % of total production worldwide. In India, maize is cultivated in an area of 9.7 million ha with a production of 30.2 million metric tonnes (DES, 2020). In Jammu and Kashmir, area under maize is 0.31 million ha with a production of 0.51 million tonnes and productivity of 1.65 t/ha (DES, 2020). Among various biotic (insect, pest, predators, weed, etc.) and abiotic factors (drought, salinity, heat, etc.) that hinder maize production, weed is considered among the foremost factors reducing the maize crop yield. It has been estimated around a 37% global loss in total maize production due to weeds. (Sharma, N. & Rayamajhi, M. 2022). The yield losses due to weeds in India is 20-60%. (Kumar, *et al*. 2019). Similarly, in Kashmir losses in yield due to weeds is 22.9 % (Dar. *et al*, 2017). Weeds reduce crop yield by competing for light, water, nutrients and CO_2, interfere with harvesting and increase the cost of cultivation (Kumawat, *et al*. 2019). Weeds possess a more competitive relationship with the applied plant nutrients than that of crops because nutrient absorption in weeds is often faster and higher than that in crop plants (Ghosh, *et al*. 2020). The critical period of crop-weed competition is 15-45 days after sowing (6 weeks) in maize (Mishra, *et al.* 2020). The harmful effects of weeds include crop growth inhibition, added protection costs, with resulting effects on water management and human health (Karimmojeni, *et al*. 2021). Timely and accurate assessment of pressure from competition is very crucial for ecological weed management (Lou, *et al*. 2022).

Topramezone is the first herbicide belonging to a new chemical class called pyrazolones. It inhibits the enzyme 4-hydroxyphenyl-pyruvat-dioxygenase. As a result, the biosynthesis of plastochinones and indirectly of carotinoides stops, which leads to disruption of the synthesis and function of chloroplasts. Consequently, chlorophyll is destructed by oxidation. The common symptoms include bleaching of the growing shoot tissue and subsequent necrosis of the aboveground plant matter. Topramezone is taken up by the shoot and the roots. Due to strongly pronounced foliar activity of this compound even against advanced weed growth stages, topramezone is used as post-emergence in maize at 1 to 8 leaf stage (Apparao, *et al*. 2015).

Halosulfuron is a sulfonylurea herbicide that inhibits acetolactate synthase (ALS), which is a key enzyme for synthesis of branched chain amino acids leucine, isoleucine, and valine in plants. Halosulfuron can be applied as pre-emergence as well as post-emergence in maize. This herbicide causes rapid growth inhibition in susceptible plants within 14-21 days. Similar to other sulphonylurea herbicides, halosulfuron is active at low doses, has low mammalian toxicity, and has low potential to contaminate ground water and the environment (Vencill, *et al*. 2002).

Tembotrione is a novel maize herbicide that is effective against a wide range of broadleaf and grassy weeds and especially as post-emergence. It inhibits 4-hydroxy phenyl pyruvate dioxygenase (HPPD) enzyme which catalyzes the conversion of 4-hydroxyphenylpyruvate to homogentisate leading to depletion of carotenoids and an absence of chloroplast development in emerging foliar tissue which then appears bleached and stunted (Hawkes, 2007) (Kaur, *et al.* 2019).

Materials and Methods

A research trial was conducted at Agronomy Research Farm, Division of Agronomy, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and technology of Kashmir, Wadura, India during *Kharif* season 2023. The soil of the experimental site had a silty-clay loam texture with pH of 7.3, electrical conductivity of 0.38 dS/m, soil organic carbon of 0.77 and 282.6 kg/ha, 16.2 kg/ha and 180.6 kg/ha of available nitrogen, phosphorus and potassium respectively. The research trial included 14 treatments of weed management laid out in randomized complete block design with three replications. The different doses of herbicidal treatments were topramezone 10 g/ha, topramezone 20 g/ha, topramezone 30 g/ha, topramezone 40 g/ha, halosulfuron 20 g/ha, halosulfuron 40 g/ha, halosulfuron 60 g/ha, halosulfuron 80 g/ha, tembotrione 30 g/ha, tembotrione 60 g/ha, tembotrione 90 g/ha and tembotrione 120 g/ha. Weed free (20, 40 and 60 DAS) and weedy check were also included. Atrazine 1 kg/ha was sprayed as pre-emergence (2 DAS) in all treatments except weed free and weedy check. The seeds of maize were sown at a spacing of 60 × 20 cm using 20 kg seed per hectare at 22nd meteorological week during the crop growing season. The mean monthly maximum and minimum temperature was 30.6 ℃ and 16.5 ℃. The total rainfall received during 2023 was 157 mm. At the time of sowing, the soil moisture was sufficient for germination and emergence. Uniform doses of 75, 40 and 20 N, P and K respectively, were applied. Five plants were randomly selected from each experimental plot to record the data on plant height, leaf area index, and dry matter accumulation at 20 days interval. While observations on grain yield and yield attributes, *viz*. number of cobs/plant, number of rows/cob, number of grains/row, seed index were recorded at harvest. Using minimum support price and current market price of the products, economics of the treatments was computed. The data on weedy density and weedy dry matter during 40 and 60 DAS were recorded by using quadrant (25 × 25 cm).

The B:C ratio calculated by taking the ratio of gross returns and cost of cultivation was determined to evaluate the economic viability of the treatments. The data were subjected to analysis of variance and significant differences among the treatments were tested by calculating CD at 5 % level of significance evaluated using one-way ANOVA (Gomez and Gomez 1984).

The following indices of weed control performance were recorded:

1. **Weed control efficiency (WCE)** gives per cent reduction in weed density by a treatment (Nath *et al*. 2016)

$$WCE (\%) = [(WD_C - WD_T)*100]/ WD_C.$$

Where, WD_C and WD_T are weed densities in control and treated plots respectively.

2. **Weed control index (WCI)** indicates per cent reduction in weed dry weight by a treatment (Nath *et al*. 2016).

$$WCI\ (\%) = [(WM_C - WM_T) *100]/ WM_C.$$

Where, WM_C and WM_T are weed dry weights in control and treated plots respectively.

3. **Weed index (WI)** is a measure of efficacy of a treatment in terms of yield output when compared with weed free treatment. It gives per cent reduction in yield loss (Asres and Das 2011).

$$WI\ (\%) = (Y_F - Y_T)/ Y_F$$

Where, Y_F and Y_T are yield in weed free and treated plots respectively.

Weed density and weed dry matter was subjected to square root transformation using $\sqrt{x+1}$ prior to statistical analysis. The data were subjected to analysis of variance and significant differences among the treatments were tested by calculating CD at 5 % level of significance evaluated using one-way ANOVA (Gomez and Gomez 1984).

Results and Discussion

Growth parameters

Weed free recorded maximum plant height among all the treatments which was at par to tembotrione 120 g/ha, tembotrione 90 g/ha, halosulfuron 80 g/ha, halosulfuron 60 g/ha, topramezone 40 g/ha, topramezone 30 g/ha. It may be attributed to reduced weed growth which might have favored vegetative growth of maize. Similar results were obtained by Arunkumar *et al*. (2020) and Rani *et al*. (2021) (Table 1).

Table 1 : Plant height (cm) of maize as influenced by different herbicides

Treatments	Plant height (cm)					
	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	Harvest
Topramezone 10/ha	29.84	63.43	139.30	190.77	225.14	230.94
Topramezone 20/ha	32.49	64.54	140.53	192.63	225.37	232.95
Topramezone 30/ha	32.99	69.87	147.53	207.93	234.28	238.43
Topramezone 40/ha	33.22	70.68	149.50	210.00	235.53	239.85
Halosulfuron 20 g ha	30.79	65.65	140.25	190.42	224.99	230.55
Halosulfuron 40 g/ha	33.85	67.29	143.56	195.63	225.15	232.77
Halosulfuron 60 g/ha	33.37	72.64	148.07	207.58	235.72	238.94
Halosulfuron 80 g/ha	33.40	73.68	149.83	210.56	237.09	242.13
Tembotrione 30 g/ha	33.37	65.74	140.00	190.87	225.06	229.90
Tembotrione 60 g/ha	33.70	68.31	143.53	196.22	226.49	232.49
Tembotrione 90 g/ha	33.05	72.55	147.47	208.10	235.65	239.62
Tembotrione 120 g/ha	33.86	73.58	150.00	210.63	238.50	242.86
Weed free	32.90	75.98	153.31	215.67	241.12	245.38
Weedy check	30.43	58.84	128.88	175.68	197.77	201.68
SEm (±)	1.52	2.01	2.28	2.71	2.30	2.44
CD (p≤0.05)	NS	6.14	6.96	8.28	7.02	7.46

Table 2 : Leaf area index as influenced by different herbicides

Treatments	Leaf area index					
	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	Harvest
Topramezone 10/ha	0.35	2.05	4.15	2.77	2.09	1.43
Topramezone 20/ha	0.35	2.24	4.22	2.90	2.22	1.58
Topramezone 30/ha	0.35	2.61	4.38	3.00	2.26	1.77
Topramezone 40/ha	0.35	2.66	5.22	3.82	3.17	2.68
Halosulfuron 20 g ha	0.35	2.09	4.21	2.92	2.19	1.55
Halosulfuron 40 g/ha	0.35	2.27	4.30	2.97	2.23	1.66
Halosulfuron 60 g/ha	0.35	2.61	4.41	3.20	2.31	1.77
Halosulfuron 80 g/ha	0.35	2.80	5.25	3.93	3.23	2.71
Tembotrione 30 g/ha	0.35	2.14	4.13	2.80	2.20	1.57
Tembotrione 60 g/ha	0.35	2.27	4.20	2.93	2.24	1.75
Tembotrione 90 g/ha	0.35	2.63	4.69	3.28	2.45	1.85
Tembotrione 120 g/ha	0.35	2.83	5.27	3.99	3.29	2.82
Weed free	0.35	3.09	5.65	4.32	3.35	2.86
Weedy check	0.35	1.16	2.81	2.24	1.53	0.84
SEm (±)	0.00	0.16	0.15	0.18	0.07	0.06
CD (p≤0.05)	NS	0.49	0.46	0.54	0.22	0.19

At 40 DAS, maximum leaf area index was observed under weed free which was at par to tembotrione 120 g/ha, tembotrione 90 g/ha, halosulfuron 80 g/ha, halosulfuron 60 g/ha, topramezone 40 g/ha and topramezone 30 g/ha. However from 60 DAS till harvest, weed free has recorded the maximum leaf area index. which was at par to tembotrione 120 g/ha, halosulfuron 80 g/ha and topramezone 40 g/ha. The minimum LAI was observed under weedy check. The outcomes closely align with the findings of Kaur *et al*. (2020) and Arunkumar *et al*. (2020). (Table 2).

Dry matter accumulation was found maximum in weed free which was statistically at par to tembotrione 120 g/ha, tembotrione 90 g/ha, halosulfuron 80 g/ha, halosulfuron 60 g/ha, topramezone 40 g/ha, topramezone 30 g/ha. The results correspond with the reports of Bahrami *et al*. (2023) and Jadhav *et al*. (2023) (Table 3).

Table 3 : Dry matter accumulation (g/plant) as influenced by different herbicides

Treatments	Dry matter accumulation (g/plant)					
	20 DAS	40 DAS	60 DAS	80 DAS	100 DAS	Harvest
Topramezone 10/ha	10.94	32.00	130.27	166.24	178.41	182.61
Topramezone 20/ha	11.50	33.66	136.39	171.24	181.47	185.52
Topramezone 30/ha	11.48	42.56	140.49	177.88	185.55	188.50
Topramezone 40/ha	11.48	42.97	145.65	182.26	189.40	193.48
Halosulfuron 20 g ha	10.75	33.24	129.93	166.60	178.31	184.93
Halosulfuron 40 g/ha	10.77	35.24	133.91	173.68	182.46	186.45
Halosulfuron 60 g/ha	11.50	43.13	139.47	177.21	186.39	188.26
Halosulfuron 80 g/ha	11.48	44.71	146.26	182.45	190.61	196.04
Tembotrione 30 g/ha	9.99	35.38	131.03	168.69	177.25	185.11
Tembotrione 60 g/ha	10.85	35.43	133.60	171.35	180.60	186.83
Tembotrione 90 g/ha	11.37	43.00	139.72	177.77	186.35	189.52
Tembotrione 120 g/ha	11.53	46.66	148.63	182.86	191.76	196.35

Weed free	13.78	49.08	156.94	187.53	197.23	200.91
Weedy check	9.80	22.77	119.72	156.37	167.76	173.72
SEm (±)	0.64	2.30	3.70	2.94	2.62	2.74
CD ($p \leq 0.05$)	NS	7.0	11.3	9.0	8.0	8.4

Yield attributing characters

The use of the different herbicides over weed control considerably enhanced the yield attributes of maize. The maximum yield attributing characters were recorded under weed free treatment which was statistically at par to tembotrione 120 g/ha, tembotrione 90 g/ha, halosulfuron 80 g/ha, halosulfuron 60 g/ha, topramezone 40 g/ha, topramezone 30 g/ha. This increased yield attributes may be credited to higher growth and development of maize due to improved weed management practices adopted. The results are in coherence with the reports of Bhagat, S. (2020), Kumar *et al*. (2023) (Table 4).

Yield

Grain yield, stover yield and biological yield varied significantly over the various treatments. Weed free recorded the maximum grain yield, stover yield and biological yield which was statistically at par to tembotrione 120 g/ha, tembotrione 90 g/ha, halosulfuron 80 g/ha, halosulfuron 60 g/ha, topramezone 40 g/ha, topramezone 30 g/ha among all the treatments.

Table 4 : Yield attributes of maize as influenced by different herbicides

Treatments	No. of cobs/plant	No. of rows/cob	No. of grains/row	Seed index
Topramezone 10/ha	1.27	11.40	23.43	18.07
Topramezone 20/ha	1.27	12.07	23.91	18.69
Topramezone 30/ha	1.33	13.44	25.08	21.30
Topramezone 40/ha	1.40	14.16	25.72	21.63
Halosulfuron 20 g ha	1.27	11.55	23.80	18.10
Halosulfuron 40 g/ha	1.27	11.80	24.17	18.22
Halosulfuron 60 g/ha	1.33	13.21	25.25	21.40
Halosulfuron 80 g/ha	1.40	14.20	26.55	22.13
Tembotrione 30 g/ha	1.27	11.91	23.83	19.08
Tembotrione 60 g/ha	1.27	12.09	23.86	21.09
Tembotrione 90 g/ha	1.33	13.29	25.10	21.72
Tembotrione 120 g/ha	1.40	14.43	27.65	22.63
Weed free	1.53	14.44	27.74	22.81
Weedy check	1.07	10.87	21.27	17.90
SEm (±)	0.07	0.43	0.93	0.53
CD ($p \leq 0.05$)	0.21	1.31	2.83	1.63

The minimum yield output was recorded under weedy check. It can be said that higher weed infestation was the reason in reducing grain yield of maize which faced higher competition with vigorous infestation of weeds. Harvest index was found significantly higher in weed free than weedy check. Similar findings were obtained by Arunkumar *et al*. (2020) (Table 5).

Table 5 : Yield and economics of maize as influenced by different herbicides

Treatments	Grain yield (t/ha)	Stover yield (t/ha)	Biological yield (t/ha)	Harvest index	B:C ratio
Topramezone 10/ha	3.60	7.47	11.07	32.48	1.67
Topramezone 20/ha	3.68	7.73	11.41	32.30	1.66
Topramezone 30/ha	5.51	8.70	14.21	38.81	2.29
Topramezone 40/ha	5.57	9.75	15.33	36.45	2.28
Halosulfuron 20 g ha	3.51	7.57	11.08	31.69	1.66
Halosulfuron 40 g/ha	3.78	7.83	11.60	32.59	1.73
Halosulfuron 60 g/ha	5.50	8.84	14.34	38.59	2.37
Halosulfuron 80 g/ha	5.63	9.86	15.49	36.38	2.41
Tembotrione 30 g/ha	3.92	7.67	11.60	33.86	1.84
Tembotrione 60 g/ha	4.30	7.62	11.92	36.04	1.95
Tembotrione 90 g/ha	5.68	9.18	14.85	38.23	2.50
Tembotrione 120 g/ha	5.93	10.09	16.03	37.05	2.59
Weed free	6.08	10.46	16.54	36.78	2.67
Weedy check	2.80	6.20	9.00	31.09	1.46
SEm (±)	0.16	0.38	0.38	1.46	---
CD ($p \leq 0.05$)	0.48	1.17	1.15	4.45	---

Economics

After weed free, tembotrione 120 g/ha recorded highest benefit: cost ratio with maximum gross return. This may be attributed to higher yield as compared to other treatments. These results are in close coherence with the findings of Akhtar *et al*. (2017), Barua *et al*. (2019) and Kakade *et al*. (2020) (Table 5).

Weed density

The major weeds collected from the research trial were *Lolium perenne, Digitaria sanguinallis, Sorghum halepanse and Panicum repens* among grasses. *Convolvulus arvensis, Portulaca oleracea, Hibiscus trionum, Matricaria discoidea, Chenopodium album, Cirsium arvense, Brassica rapa* and *Galinsoga parviflora* among broad-leaf weeds and *Cyperus rotundus* among sedges. The weed density was found significantly lower in weed free plots at 40 and 60 DAS. Among the herbicides, the lowest weed density was recorded in tembotrione 120 g/ ha which was at par to halosulfuron 80 g/ha and topramezone 40 g ha^{-1}. The remarkable reduction weed density may be attributed to control of weeds by the higher doses of the post-emergent herbicides under study. Halosulfuron 80 g/ha successfully controlled several weeds mainly *Cyperus rotundus* as it is mostly a sedge killer. Similar reports were also observed by Desai *et al*. (2017) and Dey *et al*. (2018). Among the different herbicides, tembotrione 120 g ha^{-1} was recorded to be most efficient in reducing the total weed density. The results are in close justification of the findings of Ghrasiram *et al*. (2020) and Sreelatha *et al*. (2020) (Table 6).

Weed dry matter

The minimum weed dry matter was found in weed free plots at 40 and 60 DAS. Among the treatments, tembotrione 120 g/ha recorded the least weed dry matter which was at par to halosulfuron 80 g/ha and topramezone 40 g/ha both at 40 and 60 DAS. Among the different herbicides, tembotrione 120 g/ha was recorded to be most efficient in reducing the total weed dry matter. Similar findings were reported by Ghrasiram *et al.* (2020) and Sreelatha *et al.* (2020) (Table 6).

Table 6 : Weed density and weed dry matter as influenced by different herbicides

Treatments	Weed density (no. m^{-2})				Weed dry matter (g m^{-2})			
	40 DAS		60 DAS		40 DAS		60 DAS	
	*T	O	*T	O	*T	O	*T	O
Topramezone 10 g/ha	12.45	154.67	14.26	202.67	18.00	323.84	13.40	178.93
Topramezone 20 g/ha	8.97	80.00	8.97	80.00	13.17	173.17	12.05	144.27
Topramezone 30 g/ha	7.35	53.33	6.58	42.67	11.77	138.08	10.36	106.45
Topramezone 40 g/ha	5.20	26.67	6.16	37.33	11.44	130.08	9.28	85.71
Halosulfuron 20 g/ha	11.34	128.00	10.85	117.33	14.34	205.12	12.89	165.33
Halosulfuron 40 g/ha	7.71	58.67	8.97	80.00	13.03	169.07	11.62	134.19
Halosulfuron 60 g/ha	7.35	53.33	5.62	32.00	11.74	137.97	10.28	105.01
Halosulfuron 80 g/ha	4.66	21.33	4.66	21.33	10.42	109.07	9.26	85.44
Tembotrione 30 g/ha	8.97	80.00	10.87	117.33	14.16	199.73	12.56	157.17
Tembotrione 60 g/ha	8.06	64.00	5.62	32.00	11.68	136.75	9.57	90.93
Tembotrione 90 g/ha	6.58	42.67	4.12	16.00	11.49	132.16	9.28	85.71
Tembotrione 120 g/ha	3.62	16.00	2.04	5.33	9.62	92.05	7.95	63.73
Weed free	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Weedy check	16.49	272.00	16.79	282.67	23.38	545.97	22.16	489.97
SEm (±)	0.57	---	0.54	---	0.58	---	0.45	---
CD ($p \leq 0.05$)	1.73	---	1.64	---	1.77	---	1.36	---

Note: O= Original, *T= Transformed (data subjected to square root transformation)

Weed control performance

All the herbicidal treatments showed higher weed control efficiency compared to weedy check plot. After weed free, the maximum weed control efficiency was observed with tembotrione 120 g/ha followed by halosulfuron 80 g/ha and topramezone 40 g/ha. Among the different herbicidal treatments, the maximum weed control efficiency was recorded with tembotrione 120 g/ha. The results are in close coherence with the findings of Jaybhaye (2019), Kantwa *et al.* (2020), Kumar *et al.* (2023) and Mastkar *et al.* (2022). Similarly, all the herbicides showed higher weed control efficiency compared to weedy check plot. Tembotrione 120 g/ha followed by halosulfuron 80 g/ha and topramezone 40 g/ha recorded the maximum weed control index next to weed free. Among the herbicides, the maximum weed control index was observed with tembotrione 120 g/ha. Similar reports have been observed by Radheshyam *et al.* (2021). The lower value of WI was recorded with tembotrione 120 g/ha next to weed free. These results corroborate with the findings of Kaur *et al.* (2018), Arunkumar *et al.* (2020), Kumar *et al.* (2023) and Sachan *et al.* (2023) (Table 7).

Table 7 : Weed control performance in maize as influenced by different herbicides

Treatments	Weed control efficiency (%)		Weed control index (%)		Weed index (%)
	40 DAS	60 DAS	40 DAS	60 DAS	
Topramezone 10/ha	41.39	27.04	40.22	63.42	40.90
Topramezone 20/ha	70.56	70.90	68.39	70.56	39.47
Topramezone 30/ha	79.86	84.35	74.55	78.25	9.32
Topramezone 40/ha	89.72	86.73	76.01	82.56	8.39
Halosulfuron 20 g ha	53.75	57.09	62.50	66.24	42.23
Halosulfuron 40 g/ha	78.33	70.36	69.08	72.58	37.88
Halosulfuron 60 g/ha	80.42	88.48	74.90	78.58	9.63
Halosulfuron 80 g/ha	91.81	92.53	79.74	82.57	7.38
Tembotrione 30 g/ha	69.58	57.01	63.38	67.96	35.51
Tembotrione 60 g/ha	76.11	87.77	74.99	81.46	29.36
Tembotrione 90 g/ha	83.75	94.20	75.56	82.56	6.71
Tembotrione 120 g/ha	93.61	98.33	82.97	86.95	2.44
Weed free	100.00	100.00	100.00	100.00	0.00
Weedy check	0.00	0.00	0.00	0.00	54.01

Conclusion

The generalization of the results of the experiment prompted to the conclusion that tembotrione 42% SC at 120 g/ha was most effective in improving crop growth, development, yield attributes and yield parameters and benefit: cost ratio, weed control performance.

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Conflict of interest

The authors declare no conflict of interest. All authors agree to publish it.

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