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Bio-efficacy of Post Emergent Application of Tembotrione on Mixed Weed Flora in Spring Maize (*Zea mays* L.) Under Irrigated Sub-tropical Shiwalik Foothills of J&K, India

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A field experiment was conducted at the research farm of SKUAST-J, Chatha Jammu, during the spring season 2013 to evaluate the efficacy of tembotrione (42% SC), a relatively new post emergence herbicide against mixed weed flora in spring maize. The experimental field was highly infested with *Cyperus rotundus*, *Cynodon dactylon*, *Phyllanthus niruri* and *Digitria sanguinalis*. Post emergence application of tembotrione @ 120 g ha^{-1} at 15 DAS not only reduced the total weed population, weeds dry weight and weed index but also increased the weed control efficiency, grain and stover yields which was at par with post emergence application of tembotrione @ 120 g ha^{-1} at 30 DAS and two hand weeding at 15 and 30 DAS. Highest net returns of `43, 975 $ha^{-1}$ and B: C ratio of 1.88 were obtained with the treatment tembotrione post emergence @ 120 g $ha^{-1}$ at 15 DAS followed by the treatment tembotrione post emergence @ 120 g $ha^{-1}$ at 30 DAS of `43, 028 and 1.84, respectively.

Introduction

Maize (*Zea mays* L.) occupies a pride place in India both as food and feed for animals and is an important cereal crop after rice and wheat. Most of the maize crop culture in the state of J&K is practiced during the *kharif* season i.e. June to September with an effective crop growth period ranging from 90-120 days. Maize a versatile crop has a great potential to grow not only in summer but during winter and spring seasons also in the foot-hill and mid-hill conditions in the state. Its cultivation is gaining popularity in spring season owing to its higher production and lesser time taken as compared to *kharif* maize. Also, spring maize is by and large safer from insect-pest attack and can be grown in areas where adequate irrigation facilities are available. Thus, it is a source of additional income generation for farmers during off season or when the field are left fallow after *rabi* crop culture.

The area under the winter and spring maize is meager in the country and the low productivity of spring planted maize can be attributed to several factors and all but one factor amongst those is poor weed management. Among the various pests, weeds compete with crop plants for nutrients, water, sunlight and space. Presence of weeds reduces the photosynthetic efficiency, dry matter production and distribution to economical parts and thereby reduces sink capacity of crop resulting in poor grain yield. Thus yield losses due to season long weed infestation range from 30 % to 45 % leading to crop failure (Pandey *et al.,* 2001). Unlike other pests, weeds are ubiquitous and affect almost all the crops. Weeds cause enormous damage to the maize crop, the magnitude of loss varying from 30-50 %depending upon the growth and persistence of weed population in standing crop (Rout and Satapathy, 1996).

As regards the various weed control measures manual eradication has proved its superiority over all the measures in managing weeds, however the adoption of this technique has not gained popularity amongst the farmers as it is time consuming, labour intensive, expensive and many a times becomes impractical because of scarcity of labour during peak labour need periods. Management of weeds through the use of chemicals has also been found as effective as realized under manual eradication in various crops including maize. Application of pre-emergent and post-emergent herbicides would make the herbicidal weed control more acceptable to farmers, which will not change the existing agronomic practices but will allow for complete control of weeds. Application of pre-emergence herbicides assumes greater importance in the view of their effectiveness from initial stages. As the weeds interfere during the harvesting of the crop, post emergence herbicides at about 40-45 DAS may help in avoiding the problem of weeds at later stages. But there was no post emergence herbicides still available in market, unfortunately if in any case farmer skip the application of pre-emergent herbicides and due to scarcity of labour then there was no alternative for him to control the weeds emerging in later stages, now a post emergence herbicide came into existence i.e. Tembotrione, a new post emergent broad spectrum systemic herbicide belongs to group Triketone, is a pigment synthesis inhibitor, inhibits 4-HPPD enzyme, controls broad leaved as well as grassy weeds. Managing weeds through pre-emergence and post emergence herbicides will be an ideal means for controlling the weeds in view of their economics and effectiveness in maize. Keeping in view the above facts, the present investigation was initiated to study the Bio-efficacy of post emergent application of tembotrione on mixed weed flora in spring maize (*Zea mays* L.) under irrigated sub-tropical shiwalik foothill conditions of J&K.

Materials and Methods

The field experiment was conducted during the spring season of 2013 at the research Farm of Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu which is situated at 32^0-40′ N latitude and 74^0-58′ E longitude with an altitude of 332 m above mean sea level. The experiment was laid out in randomized block design with eleven treatment replicated thrice. The treatments consisted of tembotrione @ 110 g ha^{-1} at 15 DAS, tembotrione @ 110 g ha^{-1} at 30 DAS, tembotrione @ 120 g ha^{-1} at 15 DAS, tembotrione @ 120 g ha^{-1} at 30 DAS, tembotrione @ 31 g ha^{-1} + atrazine @ 370 g ha^{-1} at 15 DAS, atrazine @ 1 kg ha^{-1} pre emergence, pendimethalin @ 1 kg ha^{-1} pre emergence, halosulfuron methyl @ 135 g ha^{-1} at 15 DAS, 2 hand weedings at 15 DAS and 30 DAS, weedy check and weed free. Spring maize crop variety JH-3459 was sown on 29th march, 2013 in furrows maintain. Herbicides were applied with the help of knapsack sprayer using a spray volume of 500 l ha^{-1}. Pre emergence applications of atrazine @ 1 kg ha^{-1} and pendimethalin @ 1 kg ha^{-1} were done after 24 hours of sowing of spring maize crop and tembotrione @ 110 g ha^{-1}, tembotrione @ 120 g ha^{-1}, tembotrione @ 31 g ha^{-1}+ atrazine @ 370 g ha^{-1}, halosulfuron methyl @ 135 g ha^{-1} were applied after 15 days of sowing as early post emergence application whereas, post emergence application of tembotrione @ 110 g ha^{-1} and tembotrione @ 120 g ha^{-1} was done 30 days after sowing. The data on individual major weed species present in the experimental field were recorded at 30, 60, 90DAS and at harvest by placing 0.5 m^{-2} randomly at two different locations in each plots. The mean data on weeds were subjected to square root transformation ($\sqrt{x+1}$) to normalize their distribution. The number of weeds species were counted and expressed in number m^{-2} and dry weight of total weed species was recorded after drying and expressed in g m^{-2}. Observations for yield and yield attributing characters were recorded after the harvest of crop. Weed indices like weed-control efficiency and weed index were worked out to assess the efficiency of different weed control treatments by using the formulae suggested by Mishra and Mishra (1997) and Raju (1998). Economics was calculated taking into prevailing market prices of inputs and output.

Results and Discussion

Effect on weeds

The experimental field was infested mainly with broad leaved weeds *Phyllanthus niruri* (5.88-6.92%) and *Solanum nigrum* (3.76-4.24%), while the grassy weeds includes *Cynodon dactylon* (8.67-17.92%), *Digitaria sangunalis* (5.32-6.13%) and *Sorghum halpense* (3.62-4.24%). *Cyperus rotundus* was found to be the only dominant sedge (57.41-66.41%). All the weed management treatments significantly reduced the total weed population and weed dry weight as compared to weedy check plots (Tables 1, 2 and 3). However, amongst the herbicidal treatments, application of tembotrione post emergence @ 120 g ha^{-1} at 15 DAS found very effective in reducing weed density and dry weight at all stages of observation which however was at par with post emergence application of tembotrione @ 120 g ha^{-1} at 30 DAS and two hand weeding at 15 and 30 DAS. This might be happened due to tembotrione inhibits the enzyme 4-hydroxy phenyl pyruvate dioxygenase (HPPD) which disrupts the formation of carotenoids and depletion of carotenoids deprives chlorophyll, the sites of photosynthesis, of its protection against an overdose of light resulting in chlorophyll oxidation which resulted in bleaching of sensitive weeds and plants turned progressively white. Post emergence application of tembotrione @ 120 g ha^{-1} at 15 DAS was found to be more effective than its lower doses in reducing the weed density. Similar results were also documented by singh *et al.*, (2012) and Yadav *et al.*, (2012).

Weed control efficiency

Amongst the weed management treatments, highest weed control efficiency was recorded in weed free treatment while as lowest weed control efficiency was recorded in weedy check treatment (Table 4). However, amongst the herbicidal treatments highest value of weed control efficiency was recorded with post emergence application of tembotrione @ 120 g ha^{-1} at 15 DAS followed by post emergence application of tembotrione @ 120 g ha^{-1} at 30 DAS and two hand weeding at 15 and 30 DAS. The higher values of weed control efficiencies could be attributed to lower weeds number and weeds dry weight owing to better efficacy among various treatments which might have shifted the pendulum in favour of crop plants rather than weeds. Kolage *et al.*, (2004), Singh *et al.*, (2012) and Yadav *et al.*, (2012) also reported similar findings in maize.

Table.1 Effect of weed management practices on major species wise and total weed count m^{-2} at 60 days after sowing in spring maize

Treatments	Sedges	Grasses			Broad leaved		Total
	Cyperus rotundus	*Cynodon dactylon*	*Sorghum halpense*	*Digitaria sanguinalis*	*Solanum nigrum*	*Phyllanthus niruri*	
Tembotrione @ 110 g ha^{-1} at 15 DAS	5.92 (34.0)	2.23 (4.0)	2.30 (4.3)	2.50 (5.3)	2.39 (4.7)	2.94 (7.7)	8.54 (72.0)
Tembotrione @ 110 g ha^{-1} at 30 DAS	5.94 (34.3)	2.30 (4.3)	2.39 (4.7)	2.59 (5.7)	2.45 (5.0)	3.0 (8.0)	8.66 (74.0)
Tembotrione @ 120 g ha^{-1} at 15 DAS	4.61 (20.3)	1.82 (2.3)	1.92 (2.7)	2.17 (3.7)	2.07 (3.3)	2.30 (4.3)	7.04 (48.6)
Tembotrione @ 120 g ha^{-1} at 30 DAS	4.87 (22.7)	1.92 (2.7)	2.0 (3.0)	2.23 (4.0)	2.17 (3.7)	2.39 (4.7)	7.33 (52.8)
Tembotrione @ 31 g ha^{-1} + atrazine @ 370 g ha^{-1} at 15 DAS	7.97 (62.0)	3.05 (8.3)	2.88 (7.3)	2.82 (7.0)	3.0 (8.0)	3.60 (12.0)	10.84 (116.6)
Atrazine @ 1 kg ha^{-1} pre-emergence	5.97 (34.7)	2.38 (4.7)	2.45 (5.0)	2.64 (6.0)	2.50 (5.3)	3.05 (8.3)	8.77 (76.0)
Pendimethalin @ 1 kg ha^{-1} pre-emergence	9.53 (90.0)	3.27 (9.7)	2.64 (6.0)	3.11 (8.7)	2.77 (6.70)	3.87 (14.0)	12.16 (147.1)
Halosulfuron methyl @ 135 g ha^{-1} at 15 DAS	2.30 (4.3)	6.63 (43.0)	3,11 (8.7)	3.71 (12.7)	3.16 (9.0)	4.12 (16.0)	10.32 (105.7)
2 Hand weedings at 15 DAS and 30 DAS	4.96 (24.7)	2.00 (3.00)	2.07 (3.3)	2.07 (4.3)	2.24 (4.0)	2.51 (5.3)	7.59 (56.6)
Weedy check	11.91 (141.0)	6.70 (44.0)	3.16 (9.0)	3.78 (13.3)	3.21 (9.3)	4.24 (17.0)	15.70 (245.6)
Weed free	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm (±)	0.13	0.07	0.07	0.09	0.47	0.11	0.28
LSD (p=0.05)	0.35	0.20	0.22	0.28	0.14	0.32	0.84

The data were subjected to √x+1 transformation: Original values are given in parenthesis

Table.2 Effect of weed management practices on major specii wise and total weed count m^{-2} at 90 days after sowing in spring maize

Treatments	Sedges	Grasses			Broad leaved		Total
	Cyperus rotundus	*Cynodon dactylon*	*Sorghum halpense*	*Digitaria sanguinalis*	*Solanum nigrum*	*Phyllanthus niruri*	
Tembotrione @ 110 g ha^{-1} at 15 DAS	5.20 (26.0)	1.92 (2.7)	2.24 (4.0)	2.39 (4.7)	2.0 (3.0)	2.70 (6.3)	7.19 (50.7)
Tembotrione @ 110 g ha^{-1} at 30 DAS	5.38 (28.0)	2.0 (3.0)	2.30 (4.3)	2.45 (5.0)	2.07 (3.3)	2.77 (6.7)	7.43 (54.3)
Tembotrione @ 120 g ha^{-1} at 15 DAS	3.83 (13.7)	1.52 (1.3)	1.64 (1.7)	2.0 (3.0)	1.52 (1.3)	2.24 (4.0)	5.47 (29.0)
Tembotrione @ 120 g ha^{-1} at 30 DAS	4.04 (15.3)	1.64 (1.7)	1.73 (2.0)	2.07 (3.3)	1.64 (1.7)	2.30 (4.3)	5.77 (32.3)
Tembotrione @ 31 g ha^{-1} + atrazine @ 370 g ha^{-1} at 15 DAS	7.66 (57.7)	2.23 (4.0)	2.51 (5.3)	2.95 (7.7)	2.39 (4.7)	3.31 (10)	9.71 (93.4)
Atrazine @ 1 kg ha^{-1} pre-emergence	5.63 (30.7)	2.07 (3.3)	2.39 (4.7)	2.50 (5.3)	2.07 (3.3)	2.83 (7.0)	7.70 (58.3)
Pendimethalin @ 1 kg ha^{-1} pre-emergence	8.12 (65.0)	2.50 (5.3)	2.70 (6.3)	2.77 (6.7)	2.83 (7.0)	3.65 (12.3)	10.37 (106.6)
Halosulfuron methyl @ 135 g ha^{-1} at 15 DAS	3.00 (8.0)	6.10 (36.3)	2.95 (7.7)	3.51 (11.3)	3.04 (8.3)	3.96 (14.6)	9.50 (89.3)
2 Hand weedings at 15 DAS and 30 DAS	4.28 (17.3)	1.64 (1.7)	1.82 (2.3)	2.17 (3.7)	1.73 (2.0)	2.38 (4.7)	6.05 (35.7)
Weedy check	11.6 (133.7)	6.24 (38.0)	3.0 (8.0)	3.60 (12.0)	3.11 (8.7)	4.00 (15.0)	14.78 (217.4)
Weed free	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm (±)	0.26	0.05	0.06	0.06	0.08	0.10	0.21
LSD (p=0.05)	0.78	0.14	0.18	0.17	0.25	0.30	0.63

The data were subjected to √x+1 transformation: Original values are given in parenthesis

Table.3 Effect of weed management practices on periodic total weed count m^{-2} and dry matter accumulation (g m^{-2}) of weeds of spring maize

Treatments	Total weed count m^{-2}				Dry matter accumulation (gm^{-2})			
	30DAS	60DAS	90DAS	At harvest	30DAS	60DAS	90DAS	At harvest
Tembotrione @ 110 g ha^{-1} at 15 DAS	7.54 (56.00)	8.54 (72.0)	7.19 (50.7)	7.39 (53.6)	3.14 (8.9)	4.78 (21.9)	4.65 (20.6)	4.48 (19.1)
Tembotrione @ 110 g ha^{-1} at 30 DAS	12.43 (153.7)	8.66 (74.0)	7.43 (54.3)	7.60 (56.8)	4.21 (16.7)	5.00 (24.1)	4.93 (23.4)	4.73 (21.4)
Tembotrione @ 120 g ha^{-1} at 15 DAS	6.59 (42.5)	7.04 (48.6)	5.47 (29.0)	5.68 (31.3)	2.32 (4.4)	3.52 (11.5)	3.72 (12.9)	3.49 (11.1)
Tembotrione @ 120 g ha^{-1} at 30 DAS	12.39 (152.6)	7.33 (52.8)	5.77 (32.3)	5.89 (33.7)	4.30 (17.5)	3.81 (13.6)	3.66 (12.5)	3.59 (11.9)
Tembotrione @ 31 g ha^{-1} + atrazine @ 370 g ha^{-1} at 15 DAS	9.21 (85.0)	10.84 (116.6)	9.71 (93.4)	9.91 (97.4)	2.76 (6.6)	7.72 (58.6)	7.52 (55.6)	7.34 (52.8)
Atrazine @ 1 kg ha^{-1} pre-emergence	7.66 (57.8)	8.77 (76.0)	7.70 (58.3)	7.78 (59.6)	3.37 (10.4)	5.28 (26.9)	5.02 (24.2)	4.98 (23.8)
Pendimethalin @ 1 kg ha^{-1} pre-emergence	10.75 (114.7)	12.16 (147.1)	10.37 (106.6)	10.4 (106.6)	3.63 (12.2)	8.79 (76.4)	8.77 (75.9)	8.67 (74.2)
Halosulfuron methyl @ 135 g ha^{-1} at 15 DAS	8.63 (73.6)	10.32 (105.7)	9.50 (89.3)	9.66 (92.4)	3.07 (8.4)	7.38 (53.5)	7.25 (51.6)	7.07 (49.0)
2 Hand weedings at 15 DAS and 30 DAS	6.77 (44.8)	7.59 (56.6)	6.05 (35.7)	6.21 (37.6)	2.76 (6.6)	4.00 (15.1)	3.91 (14.4)	3.77 (13.2)
Weedy check	12.61 (158.1)	15.70 (245.6)	14.78 (217.4)	14.8 (218.6)	4.76 (21.7)	10.83 (116.5)	10.31 (105.3)	10.04 (99.8)
Weed free	0 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)	1.00 (0.0)
SEm (±)	0.23	0.28	0.21	0.12	0.04	0.12	0.13	0.28
LSD(p=0.05)	0.45	0.84	0.63	0.36	0.13	0.37	0.38	0.09

The data were subjected to $\sqrt{x+1}$ transformation: Original values are given in parenthesis:

Table.4 Effect of weed management practices on Weed Control Efficiency (%) and Weed Index (%) in spring maize

Treatments	Weed Control Efficiency (%) (At harvest)	Weed Index (%)
Tembotrione @ 110 g ha^{-1} at 15 DAS	80.83	11.11
Tembotrione @ 110 g ha^{-1}at 30 DAS	78.54	11.34
Tembotrione @ 120 g ha^{-1}at 15 DAS	88.79	4.53
Tembotrione @ 120 g ha^{-1}at 30 DAS	88.05	6.17
Tembotrione @ 31 g ha^{-1} + atrazine @ 370 g ha^{-1} at 15 DAS	47.06	17.30
Atrazine @ 1 kg ha^{-1}pre-emergence	76.08	12.18
Pendimethalin @ 1 kg ha^{-1}pre-emergence	25.67	22.41
Halosulfuron methyl @ 135 g ha^{-1}at 15 DAS	50.89	16.86
2 Hand weedings at 15 DAS and 30 DAS	86.69	6.60
Weedy check	0.00	40.05
Weed free	100.00	0.00

Table.5 Effect of weed management practices on yield attributes of spring maize of spring maize

Treatments	No. of plants m^{-2}	No. of cob plant^{-1}	No of grain rows cob^{-1}	No. of grains cob^{-1}	1000-grains Weight (g)	Grain yield (q ha^{-1})
Tembotrione @ 110 g ha^{-1}at 15 DAS	4.50	1.29	12.98	269.7	197.0	30.22
Tembotrione @ 110 g ha^{-1}at 30 DAS	4.49	1.28	12.94	263.0	195.3	30.14
Tembotrione @ 120 g ha^{-1}at 15 DAS	4.67	1.33	13.35	276.0	205.4	32.45
Tembotrione @ 120 g ha^{-1}at 30 DAS	4.66	1.32	13.34	274.3	203.3	31.90
Tembotrione @ 31 g ha^{-1}+ atrazine @ 370 g ha^{-1}at 15 DAS	4.48	1.22	12.48	248.6	187.6	28.11
Atrazine @ 1 kg ha^{-1}pre-emergence	4.49	1.27	12.90	261.3	194.0	29.85
Pendimethalin @ 1 kg ha^{-1}pre-emergence	4.43	1.21	11.68	240.8	182.3	26.38
Halosulfuron methyl @ 135 g ha^{-1}at 15 DAS	4.48	1.25	12.57	253.7	188.7	28.26
2 Hand weedings at 15 DAS and 30 DAS	4.64	1.3	13.34	271.6	202.5	31.75
Weedy check	4.32	1.19	12.32	230.0	175.6	20.38
Weed free	4.67	1.34	13.67	284.7	211.7	33.99
SEm (±)	0.31	0.30	0.11	2.15	1.70	0.50
LSD(p=0.05)	N.S.	N.S.	0.30	6.40	5.05	1.50

Table.6 Effect of weed management practices on yield and economics of spring maize

Treatments	Total cost of cultivation (`ha^{-1})	Net Returns (` ha^{-1})	B:C Ratio
Tembotrione @ 110 g ha^{-1}at 15 DAS	23361	40018	1.71
Tembotrione @ 110 g ha^{-1} at 30 DAS	23361	39907	1.71
Tembotrione @ 120 g ha^{-1} at 15 DAS	23432	43975	1.88
Tembotrione @ 120 g ha^{-1} at 30 DAS	23432	43028	1.84
Tembotrione @ 31 g ha^{-1} + atrazine @ 370 g ha^{-1} at 15 DAS	22937	36192	1.58
Atrazine @ 1 kg ha^{-1}pre-emergence	23318	39352	1.69
Pendimethalin @ 1 kg ha^{-1}pre-emergence	23893	32586	1.36
Halosulfuron methyl @ 135 g ha^{-1}at 15 DAS	25582	34082	1.33
2 Hand weedings at 15 DAS and 30 DAS	28282	37996	1.34
Weedy check	22282	21789	0.98
Weed free	31282	38996	1.25

Weed index

Maximum weed index value was observed in weedy check as compared to weed free which recorded negligible yield loss due to absence of weeds provided there are no other limiting factors. This can be probably ascribed due to competition offered by unchecked weed growth for nutrients, moisture and light as indicated by poor growth and yield components under weedy conditions. Among the herbicidal treatments lowest weed index was recorded with application of post emergence application of tembotrione @ 120 g ha^{-1} at 15 DAS followed by post emergence application of tembotrione @ 120 g ha^{-1} at 30 DAS and two hand weeding at 15 and 30 DAS (Table 6). This can be probably ascribed due to improved growth of crops as a consequence of effective control of weeds and reduction in the crop weed competition. This enabled the crop to take up more nutrients attributed to lower weed number and dry weight. Similar results collaborate with the findings of Singh *et al.*, (2012) and Yadav *et al.*, (2012).

Yield attributes and yield

All weed management treatments, showed non-significant results with respect to number of plants m^{-2} and number of cobs plant^{-1}

however brought significant increase in number of grains rows cob^{-1}, number of grains^{-1}cob, 1000 grain weight as compared to weedy check (Table 5). Among the herbicidal treatments post emergence application of tembotrione @ 120 g ha^{-1} at 15 DAS recorded significantly higher grain and stover yield of spring maize. It was probably due to minimum crop-weed competition throughout the crop growth period, thus enabling the crop for maximum utilization of nutrients, moisture, light and space which had influence on growth and yield components. The lowest grain yield of spring maize was noticed in weedy check as a consequence of stiff competition imposed by weeds and resulting in poor source and sinks development with poor yield contributing characters and higher weed index. Similar results corroborated with the findings of Rout and Satapathy (1996) and Kolage *et al.*, (2004). The possible reason for the higher grain yield due to herbicide application could be attributed to improved performance of tembotrione @ 120 g ha^{-1} in terms of grain yield components. This improvement in turn can be ascribed due to better weed suppression through significant reduction in dry weed weight and weed population and consequent reduction in crop-weed competition. Santel (2009) and Singh *et al.*, (2012) also reported similar findings in maize.

Economics

All the weed-control treatments recorded considerably higher net profit over weedy check (Table 6). Amongst weed management treatments, tembotrione @ 120 g ha^{-1} at 15 DAS registered highest net returns of `43,975 ha^{-1} and benefit: cost ratio (1.88) which was immediately followed by tembotrione @ 120 g ha^{-1} at 30 DAS. Higher grain yield might have been responsible for the corresponding higher net returns of all weed management treatments as compared to weedy check treatment. Another possible reason that can be ascertained to these findings is that this could have happened due to the fact that all treatments associated with weed control measures were more remunerative than weedy check with regard to net monetary returns. Similar results were also reported Roy *et al.*, (2008).

Post emergent application of tembotrione @120 g ha^{-1} either at 15 DAS or 30 DAS has been found to be an innovative and new tool in the hands of the maize farmers of the region who either could skip the pre-emergence herbicidal application or could not afford the labour intensive hand weeding.

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